Racal Communications

Instruction Manual

MODEL 332A

VOLTAGE CALIBRATOR

FLUKE

ELECTRONICS FOR INDUSTRY
INSTRUMENTS / COMPONENTS

JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133

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MODEL 332A

VOLTAGE CALIBRATOR

332A Serial no. 123 and above.

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MODEL 332A VOLTAGE CALIBRATOR

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. The Fluke Model 332A Voltage Calibrator provides a dc output of 0 to 1111.111 volts at 0 to 50 milliamperes. The calibration accuracy of ±0.003% permits the use of the 332A for calibration of precise instruments and systems. The instrument can also be used with a high-impedance null detector for differential dc voltage measurements.

1-3. The 332A incorporates three protection circuits: a current limit, a current trip, and a voltage trip. The three separate systems provide a high level of protection against possible equipment failure or operator error.

1-4. Most of the instrument circuitry is mounted on modular plug-in cards, with an extender card for maintenance and adjustment.

1-5. The use of solid-state circuitry throughout the instrument is feasible because of a preregulator, which monitors the output requirement of the instrument and reduces input power to the minimum adequate level. This reduces heat dissipation in the instrument, particularly in the series pass transistors. The preregulator is synchronous with line frequency.

1-6. The reference element for the 332A is a specially-selected zener diode which is enclosed in a proportionally-controlled oven. The constant current source for the zener diode is also enclosed in the same oven. The oven and auxiliary supplies are fully energized when the power switch is in the standby position, so that the voltage reference is maintained in a stable operating condition.

1-7. The inner chassis and circuitry are surrounded by an isolated guard, which is also isolated from the front panel and outside cover. The guard is provided for bypassing any circulating ground currents which otherwise may cause error. Remote sensing of the output voltage is also included to prevent error due to voltage drop in the load wires.

1-8. SPECIFICATIONS

OUTPUT VOLTAGE: 0 to 1111.1110 volts dc.

VOLTAGE RANGES: 10, 100, and 1000 volt ranges with outputs as follows:

0 to 11.111110 volts (1 uv steps)
0 to 111.11110 volts (10 uv steps)
0 to 1111.1110 volts (100 uv steps)

RESOLUTION: 0.1 ppm of range (1 uv maximum)

ACCURACY OF OUTPUT:

10 volt range - ±(0.003% of setting + 10 uv)
100 volt range - ±(0.003% of setting + 20 uv)
1000 volt range - ±(0.003% of setting + 40 uv)

NOTE: Above accuracies apply at standard reference conditions of 23 (±1)°C, constant line voltage, up to 70% relative humidity, and constant external load.

TEMPERATURE COEFFICIENT OF OUTPUT: Less than (0.0002% of setting + 1 uv) per °C from 0°C to +50°C.

STABILITY OF OUTPUT: (At standard reference conditions described in note above):

10 volt range
±(0.0015% of setting + 10 uv) per week
±(0.0025% of setting + 10 uv) per 6 months

100 volt and 1000 volt ranges
±(0.0015% of setting + 20 uv) per week
±(0.0025% of setting + 40 uv) per 6 months

OUTPUT CURRENT: 0 to 50 milliamperes at any output voltage.

OVERCURRENT PROTECTION: Continuously variable front panel control. Automatically limits output current at any preset level between 1 ma and 60 ma. Panel lamp illuminates during limiting. Normal operation restored upon removal of overload.

OVERVOLTAGE PROTECTION: Front panel control continuously variable from 10% to 110% of each range. Automatically disables output voltage if level exceeds selected value. Manual reset.

DESIGN: Solid-state throughout.

RIPPLE AND NOISE (all frequencies):

10 volt range - less than 20 uv rms
100 volt range - less than 30 uv rms
1000 volt range - less than 40 uv rms

OUTPUT RESISTANCE: Less than 0.0005 ohms or $0.0001E_O$ ohms (whichever is greater) at dc.

SETTLING TIME: Within 10 ppm of final output, less than 10 seconds after a range change.

LINE REGULATION: 0.0005% of setting or 25 uv for a 10% line voltage change from nominal.

LOAD REGULATION: 0.0005% of setting or 25 uv for full load change.

COMMON MODE REJECTION: Better than 140 db from dc to 400 Hz, up to 700 volts rms or 1000 volts dc. (Output voltage changes less than 10^{-7} of the applied common mode voltage.)

ISOLATION: Either output terminal may be floated up to 1000 volts dc from chassis ground.

TERMINAL CONFIGURATION:

Voltage output - 2 binding posts
Remote sense - 2 binding posts
Guard - 1 binding post
Chassis - 1 binding post

REMOTE SENSE: Separate terminals are provided for sensing the output voltage directly at the load, eliminating errors due to voltage drop in connecting wires between the instrument and load.

OPERATING TEMPERATURE RANGE: 0°C to 50°C (See ACCURACY OF OUTPUT AND TEMPERATURE COEFFICIENT OF OUTPUT).

STORAGE TEMPERATURE RANGE: -40°C to +65°C.

RELATIVE HUMIDITY: 0 to 70%.

SHOCK: Meets all test requirements of MIL-T-945A, rigidly mounted or rack-mounted with slides.

VIBRATION: Meets all test requirements of MIL-T-945A, rigidly mounted or rack-mounted with slides.

ALTITUDE: 10,000 ft. operating; 50,000 ft. non-operating.

FUNGUS NUTRIENTS: None

MERCURIC COMPONENTS: None

FUSES: One power line fuse, one high voltage fuse.

INPUT POWER: 115/230 volts ac ±10%, 50 - 60 Hz, single phase. Approximately 130 VA fully loaded.

SIZE: 7" high x 19" wide x 18" behind panel.

WEIGHT: 60 lbs.

MOUNTING: Standard EIA relay rack (tapped for attachment of slides); resilient feet provided for bench use.

SECTION II

OPERATING INSTRUCTIONS

2-1. FUNCTION OF CONTROLS, TERMINALS AND INDICATORS

2-2. The location, reference designation, and function of external controls, terminals, and indicators on the 332A are given in Figure 2-1.

2-3. USE AS A VOLTAGE CALIBRATOR

2-4. PREPARATION FOR USE

2-5. Heat producing transistors in the 332A are mounted on heat sinks in the rear of the chassis. Cooling air for these heat sinks enters through the lower perforated chassis cover and leaves through the top cover. Care must be taken to ensure that air flow is not restricted by covering the chassis perforations. The instrument is normally supplied with rubber feet for bench-top operation which raise the chassis above the bench to permit air circulation. If the feet have been removed, the chassis must be raised by some other means to provide the necessary path for airflow.

2-6. BASIC OPERATION

a. Connect the line plug to a 115 volt ac power source, or to 230 volts ac if so wired.

WARNING!

The round pin on the three-prong plug connects the instrument case to power system ground. When using a three-to-two pin adapter to connect to a two-contact outlet, connect the ground lead from the adapter to a high-quality ground.

b. Verify that the + SENSE terminal is connected to the + OUTPUT terminal, and that the - SENSE terminal is connected to the - OUTPUT terminal. Shorting links are provided for this purpose.

c. Set the CURRENT LIMIT and VOLTAGE TRIP controls fully clockwise, unless these controls have been set to specific points. (Refer to paragraphs 2-10 and 2-14.)

d. Set the VOLTAGE RANGE switch to the desired output range. For greatest accuracy, use the lowest range which will provide the required output voltage.

e. Set the output voltage dials to the desired output voltage. For greatest accuracy and best stability, the first digit should always be used in the event of two or more possible combinations for selecting the output voltage.

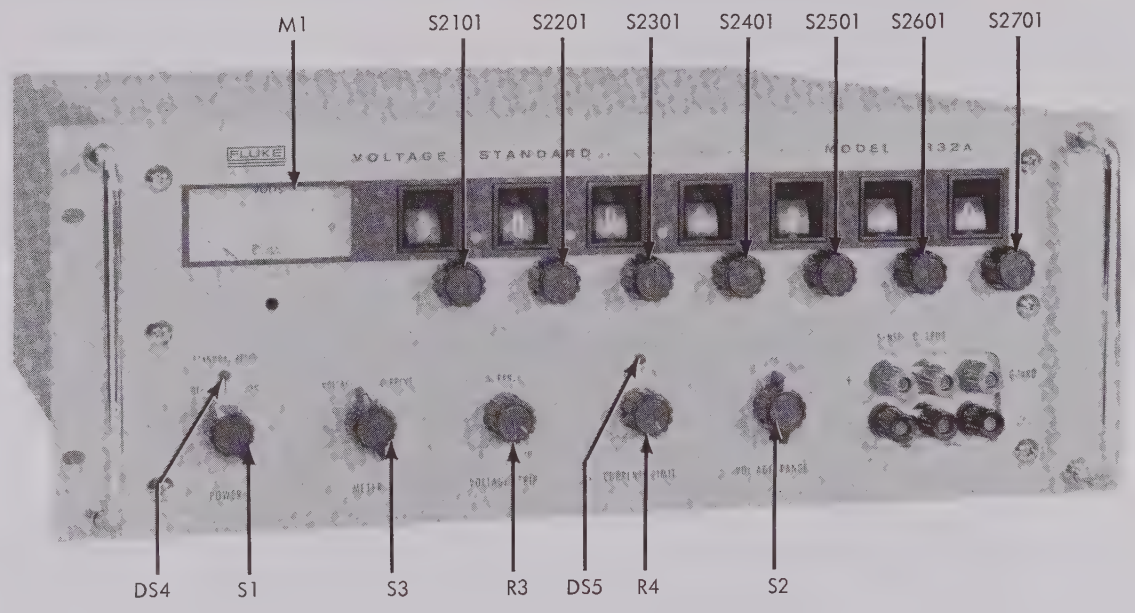
f. Connect the load to the OUTPUT terminals, and set the POWER switch to STANDBY/RESET, and then to ON.

g. To monitor the output voltage or current, set the METER switch to VOLTAGE or to CURRENT, as desired.

2-7. REMOTE SENSING

2-8. When a load is connected to the output of the 332A, there may be an appreciable voltage drop between the instrument and the load. The nomograph of Figure 2-2 can be used to determine the approximate voltage drop in the wires from the 332A to the load.

2-9. In Figure 2-2, lay a straight-edge from the output current required to the size of wire being used. The voltage drop per foot per conductor can be obtained from the third column. For example, assume AWG #30 wire is used to connect a load which requires 0.050 amperes. The voltage drop in the wires is 5.4 mv per foot of wire. If two wires, each 3 feet long, are used to connect the load, this represents a voltage drop of 32 mv, which is several times the published load regulation of the 332A at 1000 volts output. Consequently, the advantage of remote sensing is that specified load regulation is maintained at the load, the voltage drop in the connecting wires then having no effect. Remote sensing should be used when a load current is required. Proceed as follows:



CONTROL, TERMINAL, OR INDICATOR	LOCATION	REFERENCE DESIGNATION	FUNCTION
POWER switch	Front panel	S1	Applies line power to the control circuits of the instrument when set from OFF to STANDBY/ RESET. When set from STANDBY/RESET to ON, a reed relay is actuated which connects the OUT-PUT terminals to the internal circuitry. AC power is also applied to the primary of the power trans-former.
Output Voltage Dials	Front panel	S2101, S2201, S2301, S2401, S2501, S2601, S2701	Select and indicate the output voltage. The recessed numbers directly above each dial pro-vide in-line readout of the output voltage. The lamps between the numbers indicate the decimal place. Note that each dial can be set to X ($\underline{10}$ on earlier instruments). When a dial is set to $\overline{X}$ (or $\underline{10}$), the digit it represents is 0, and 1 must be added to the next higher digit. For example, $\underline{10}$ X X. X X X X and $\underline{10}$ $\underline{10}$ $\underline{10}$. $\underline{10}$ $\underline{10}$ $\underline{10}$ $\underline{10}$ both represent 1111. 1110 volts.
STANDBY/ RESET Lamp	Front panel	DS4	This lamp illuminates when the POWER switch is set to STANDBY/RESET, indicating that the OUT-PUT terminals are disconnected, and input power is removed from the high voltage transformer. This lamp also illuminates when the trip circuit has been activated.
VOLTAGE RANGE Switch	Front panel	S2	Selects the output voltage range of 10, 100, or 1000 volts, and changes the meter to a corre-sponding range.

Figure 2-1. FUNCTION OF CONTROLS, TERMINALS, AND INDICATORS (Sheet 1 of 2)

CONTROL, TERMINAL, OR INDICATOR	LOCATION	REFERENCE DESIGNATION	FUNCTION
CURRENT LIMIT Control	Front panel	R4	Varies the current limit from 1 to 60 ma, approximately.
LIMIT ON Lamp	Front panel	DS5	Indicates when the current limit is actuated. The calibrated output voltage dials no longer indicate the correct output voltage.
VOLTAGE TRIP Control	Front panel	R3	Sets the output voltage at which the instrument will switch to standby operation. Variable from 0 to 110%, approximately, of each voltage range.
METER switch	Front panel	S3	Selects meter indication of either output voltage or output current.
Meter	Front panel	M1	Indicates the output voltage or output current, depending on the position of the METER switch. The meter voltage range corresponds to the position of the VOLTAGE RANGE switch, and provides approximately 10% overrange on a 0 to 12 scale. The current range is from 0 to 60 ma.
OUTPUT terminals	Front panel		Provided for connecting the 332A to the load.
SENSE Terminals	Front panel		Provided for connecting remote sensing leads.
GUARD Terminal	Front panel		Provided for eliminating the effects of circulating ground currents. Connect the GUARD terminal only when the POWER switch is set to STANDBY/RESET or to OFF.
Ground Terminal	Front panel		Provided for grounding either the positive or negative output to power line ground, along with the instrument case.

Figure 2-1. FUNCTION OF CONTROLS, TERMINALS, AND INDICATORS (Sheet 2 of 2)

a. With the POWER switch set to OFF, or to STANDBY/RESET, remove the front-panel connections between the SENSE and OUTPUT terminals.

b. Using a twisted pair of wires, connect the + SENSE terminal to the positive side of the load, and connect the - SENSE terminal to the negative side of the load.

CAUTION!

Be sure that the + SENSE terminal is connected to the positive side of the load, and that the - SENSE terminal is connected to the negative side of the load. Incorrect connections will result in loss of regulation and possible damage to the instrument.

c. Proceed with steps c. through g. of paragraph 2-6.

2-10. CURRENT LIMIT CONTROL

2-11. The current limit is designed to protect the equipment connected to the 332A from possible damage due to excessive load current. Set the current limit as follows:

a. Set the front-panel controls on the 332A as follows:

VOLTAGE RANGE	As desired
VOLTAGE TRIP	As desired
CURRENT LIMIT	Fully clockwise
METER switch	CURRENT
Voltage dials	1 volt output
POWER switch	STANDBY/RESET

b. Short across the OUTPUT terminals.

c. Set the POWER switch to ON.

d. Set the output current limit by rotating the CURRENT LIMIT control counterclockwise until the panel meter indicates the desired limiting current.

e. Remove the short from the OUTPUT terminals, and proceed with steps e. through g. of paragraph 2-5.

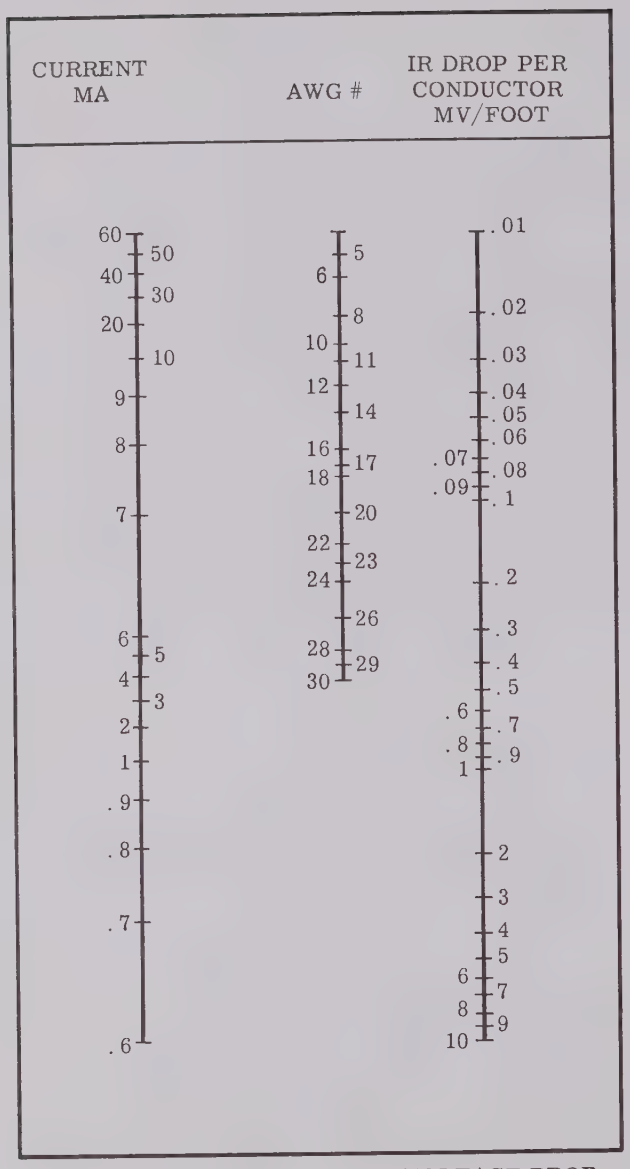


Figure 2-2. NOMOGRAPH OF VOLTAGE DROP IN LOAD WIRES

2-12. CURRENT TRIP

2-13. The 332A is provided with a fixed current trip to protect the instrument from damage due to excessive output current, in the event that the current limit should fail to operate. This current trip will automatically place the 332A in standby operation at an output current of approximately 120 ma. After correcting the overload, return the instrument to normal operation by setting the POWER switch to STANDBY/RESET, and then to ON.

2-14. VOLTAGE TRIP CONTROL

2-15. The voltage trip is designed to protect the equipment connected to the 332A from possible damage due to excessive load voltage. Set the voltage trip as follows:

a. Set the front-panel controls on the 332A as follows:

VOLTAGE RANGE	As desired
VOLTAGE TRIP	Fully clockwise
CURRENT LIMIT	As desired
METER switch	VOLTAGE
POWER switch	ON

b. Set the output voltage dials to the required output voltage.

c. Slowly rotate the VOLTAGE TRIP control counterclockwise until the STANDBY/RESET lamp illuminates. The voltage trip is set for the selected voltage.

d. Set the POWER switch to STANDBY/RESET, and then to ON.

e. During operation of the instrument, if the selected trip voltage is exceeded, the instrument will automatically switch to standby operation, as indicated by the illumination of the STANDBY/RESET lamp. If this occurs, normal operation can be restored by repeating step d.

2-16. USE AS A DIFFERENTIAL VOLTMETER

2-17. The 332A can be used in combination with the Fluke Model 845AB Null Detector as a differential voltmeter. Connection of the equipment for a positive unknown voltage is illustrated in Figure 2-3. Proceed as follows:

a. Connect the 845AB input terminal to the voltage to be measured, and connect the 845AB common terminal to the + OUTPUT terminal. Connect the - OUTPUT terminal to the common side of the unknown voltage. Do not connect the ground terminal of the 845AB, of course. When measuring negative voltages, the connections of the + and - OUTPUT terminals described above should be reversed.

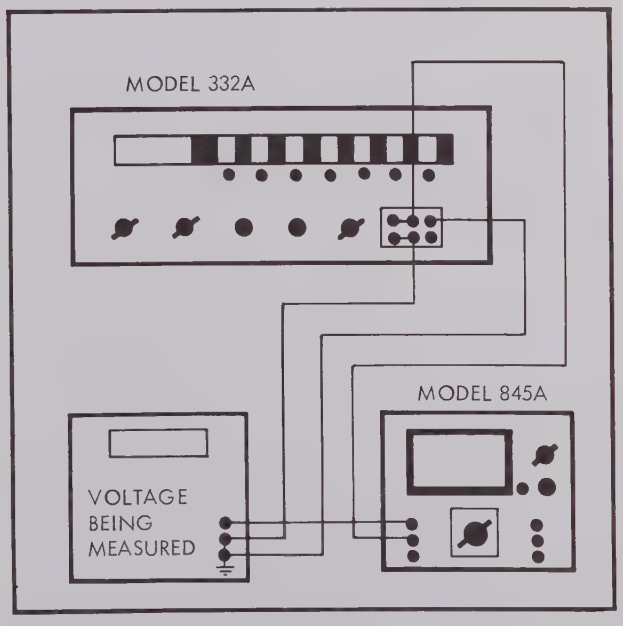


Figure 2-3. USE AS A DIFFERENTIAL VOLTMETER

b. Set the 845AB voltage range to the approximate voltage of the unknown. If the approximate voltage isn't known, set the 845AB to the 1000 volt range initially.
c. Set the front panel controls on the 332A as follows:

POWER	ON
METER	VOLTAGE
VOLTAGE TRIP	As desired
CURRENT LIMIT	As desired

d. Set the VOLTAGE RANGE switch and the voltage dials for the approximate voltage indicated by the 845AB. The 845AB should then indicate a null.
e. Set the 845AB for increased null sensitivity, and adjust the voltage dials for zero deflection of the null detector.
f. The value of the unknown voltage is indicated by the voltage dials at zero deflection of the null detector.

2-18. USE WITH A REFERENCE DIVIDER

2-19. Use of the 332A with the Model 750A Reference Divider can provide output voltages of 0.1, 0.5, 1, 1.1, 5, 10, 50, 100, 500, 1000, and 1100 volts dc which have an accuracy of 10 to 20 ppm, and are traceable to the National Bureau of Standards. Equipment connection is illustrated in Figure 2-4. Proceed as follows:

a. Turn on all equipment, and allow it to warmup to equilibrium temperature.
b. Connect a standard cell to the standard cell terminals of the 750A.
c. Connect the 845AB to the null detector terminals of the 750A. The standard cell and null detector are in series.
d. Following the procedure of paragraph 2-10, set the CURRENT LIMIT control for 2 ma.
e. Connect the OUTPUT terminals to the input voltage terminals of the 750A.

CAUTION!

Be sure the POWER switch is set to STAND-BY/RESET.

f. Set the standard cell voltage dials on the 750A to the correct standard cell voltage.
g. Set the input voltage switch of 750A as desired.
h. Set the voltage dials and VOLTAGE RANGE switch of the 332A to the positions corresponding to step g. Set the POWER switch to ON.
i. Set the 845AB for 100 uv sensitivity.
j. Adjust the voltage dials of the 332A and the coarse and fine dials of the 750A for a null in successively more sensitive null ranges of the 845AB. Final null should be on the 10 uv null range.
k. Output voltages are available at the output voltage terminals of the 750A, by setting the output voltage switch of the 750A to the desired position.

2-20. USE OF GUARD TERMINAL

2-21. The 332A is provided with a guard chassis between the inner chassis and the outside chassis (case) of the instrument. The inner chassis is electrically connected to the + SENSE terminal and is always at the same potential as the + SENSE terminal. The guard chassis completely surrounds the inner chassis, and is isolated from it, the only electrical path between the two chassis being leakage. The outside chassis (case) of the instrument completely surrounds the guard chassis, and is isolated from it, the only electrical path between these two chassis also being leakage. The outside chassis is connected to ground through the line cord. It should be noted that the ac ground of two instruments isn't usually at the same exact potential. Consequently, when the 332A output is connected to another instrument, both of which are grounded through their respective power cords, a path exists for circulating ground currents. These circulating ground currents can cause errors in the load voltage. The correct way to route these circulating ground currents so they will not cause error in the load voltage is to connect the GUARD terminal directly to the grounded load terminal, as illustrated in Figure 2-5. When thus connected, the GUARD bypasses ground currents around the load and output leads of the 332A, and the ground current causes no error.

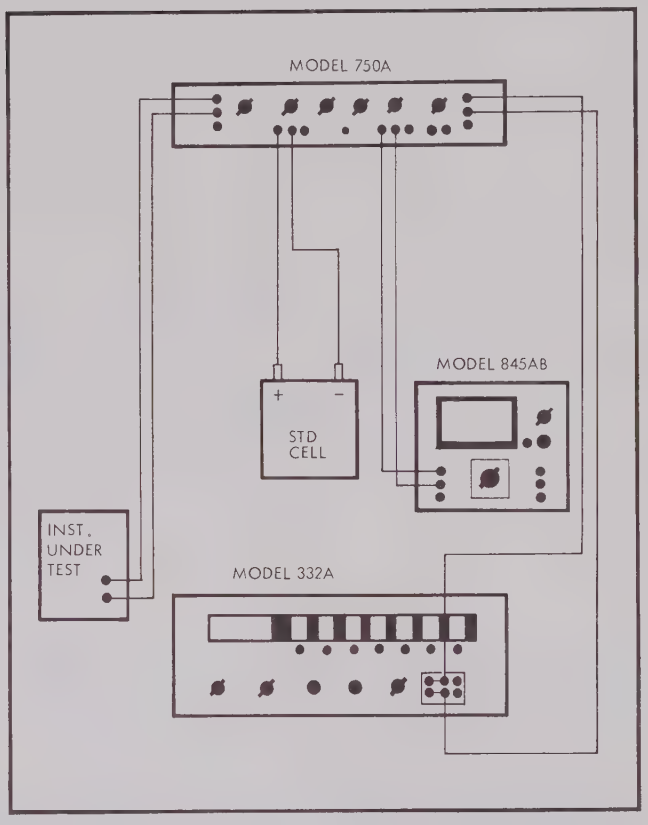
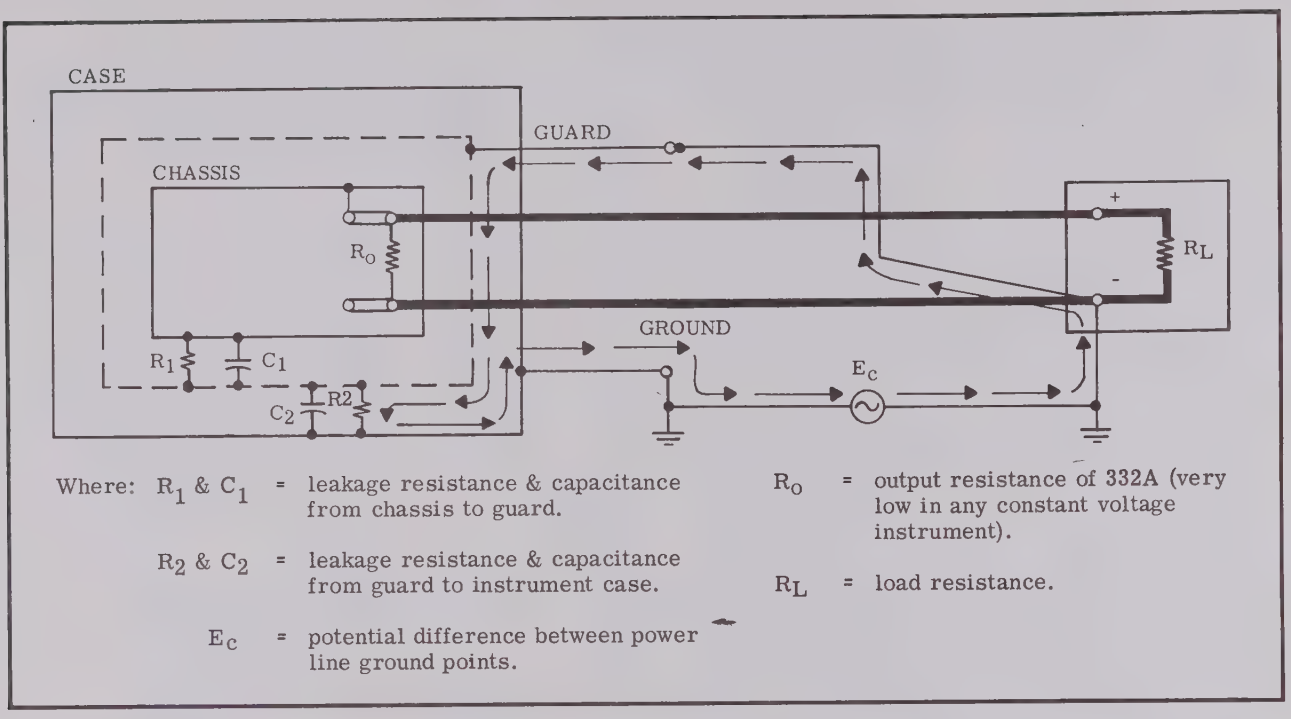


Figure 2-4. USE WITH A REFERENCE DIVIDER

2-22. Two incorrect methods of connecting the GUARD terminal are illustrated in Figure 2-6, in which the GUARD terminal is connected to the ground terminal, and to the + OUTPUT terminal. In each of these cases, part of the circulating ground current flows through the load, and can cause error in the load voltage. Similiar paths that can cause error will be noted if the GUARD terminal is connected to the - OUTPUT terminal, or to any terminal other than the grounded load terminal.



Where: R_1 & C_1 = leakage resistance & capacitance from chassis to guard.

R_2 & C_2 = leakage resistance & capacitance from guard to instrument case.

E_C = potential difference between power line ground points.

R_O = output resistance of 332A (very low in any constant voltage instrument).

R_L = load resistance.

Figure 2-5. CORRECT GUARD CONNECTION

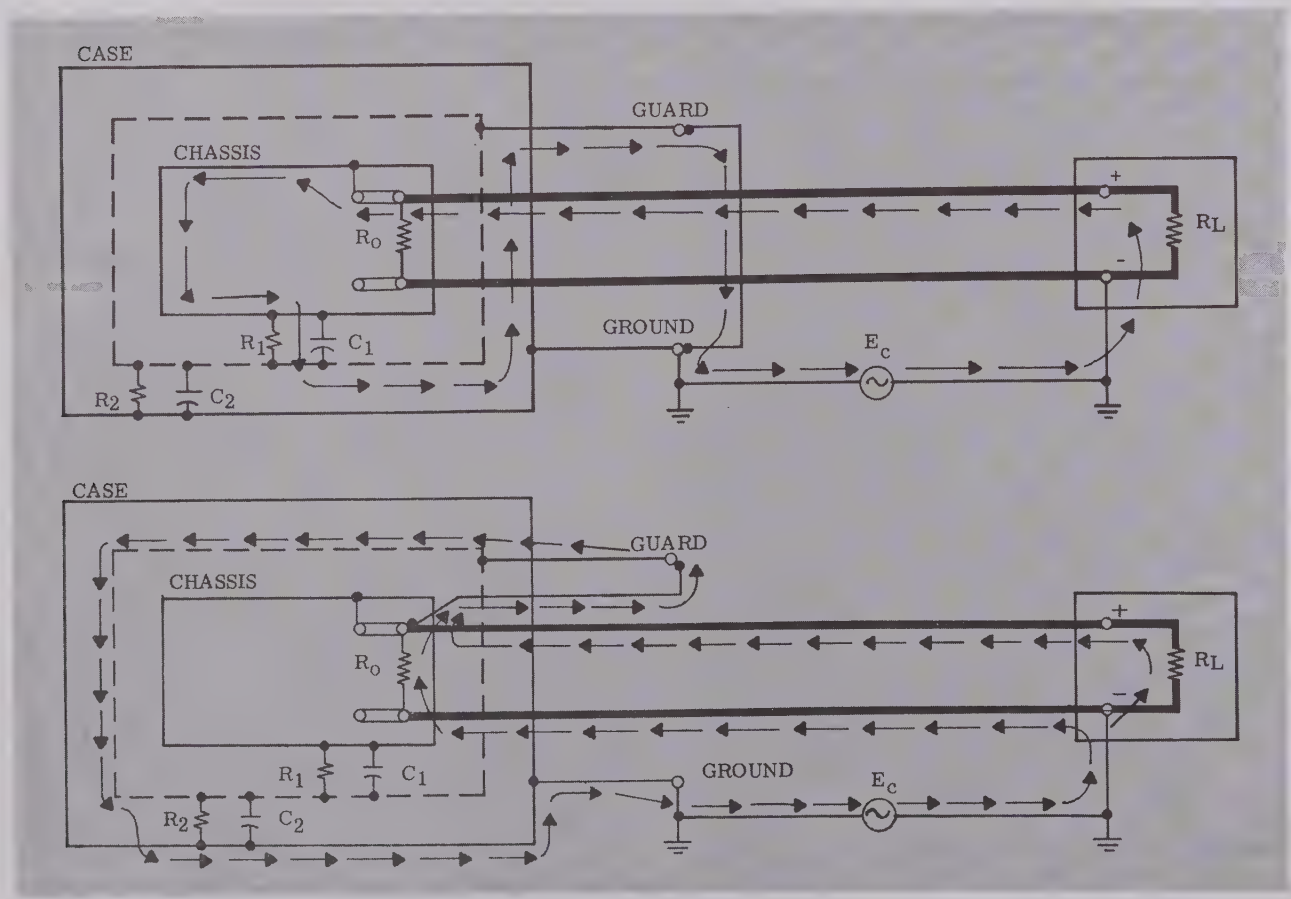


Figure 2-6. INCORRECT GUARD CONNECTIONS

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. The following paragraphs describe the theory of operation of the Model 332A. Reference is made to the functional schematic following Section V. This schematic is intended to aid in troubleshooting, and in understanding the theory of operation.

3-3. A block diagram of the Model 332A is given in Figure 3-1. The overall operation of the instrument is similar to that of an operational amplifier with variable feedback. The differential amplifier controls the output voltage, by controlling the conductance of the series pass transistors. As shown in Figure 3-1, the common of the differential amplifier is connected to the positive

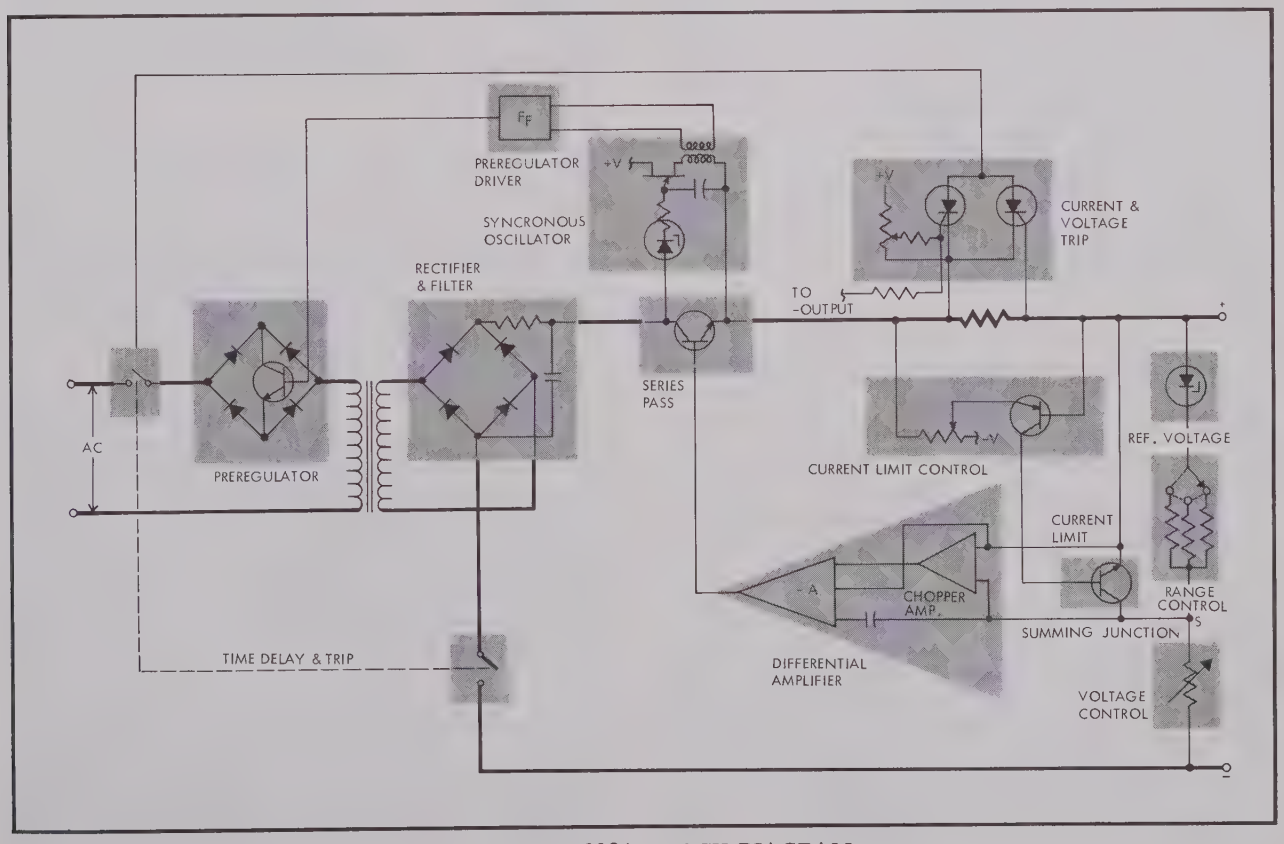


Figure 3-1. 332A BLOCK DIAGRAM

bus. The other input is connected to point S, the summing junction of the voltage control resistors and the range resistors. The action of the differential amplifier is to control the conduction of the series pass transistors so that the difference between the two inputs of the differential amplifier is zero, which means that both inputs are at positive bus potential. Since the reference voltage is constant, the current through the selected range resistor, and through the voltage control resistors, is also constant. Therefore, the output voltage is equal to the voltage drop across the control resistors, and can be varied by changing the resistance of the voltage control (feedback) string. One terminal of the voltage control string and one terminal of the differential amplifier may be connected directly to the load for remote sensing.

3-4. The 332A uses a preregulator in the primary of the high voltage transformer. The preregulator consists of a bridge rectifier circuit with an npn transistor, Q1207, connected as a synchronous switch for the bridge. The transistor is driven by an error signal from the preregulator control, so that the transistor regulates the power flowing through the bridge, and consequently through the primary of the high voltage transformer. Use of the preregulator reduces the amount of power dissipation required from the series pass transistors at low output voltage. The bridge transistor provides an approximately linear control of the input current.

3-5. The reference voltage for the preregulator is obtained from zener diode CR1111, which is connected across the series pass transistors. When the voltage across the series pass transistors exceeds approximately 50 volts, capacitor C1104 charges through CR1111, R1110, and R1124. When the capacitor is charged to the firing voltage of the unijunction transistor Q1101, the transistor conducts, and discharges C1104 through T1101 and R1108, thus causing a pulse across T1101. The initial pulse stops conduction through Q1207 for the remainder of that particular half-cycle, thus momentarily interrupting input power to transformer T2. Normally, the voltage across the series pass transistors will stabilize at the zener voltage of 50 volts. If more load current is required, the conductance of the series pass transistors will increase, maintaining the load voltage constant, and reducing the collector-emitter voltage of the series pass transistors. When the voltage across the series pass transistors becomes less than approximately 50 volts, the unijunction oscillator is turned off, which removes the turn-off signal from Q1207. Thus, more power flows into the series pass transistors, which increases the voltage drop across the transistors to a steady-state value.

3-6. It should be noted that if the output voltage is suddenly turned to zero with a load connected to the instrument, the voltage of filter capacitors C1301, C1302, and C1303 would appear across the series pass transistors. This voltage could damage the series pass transistors. When the output voltage is suddenly reduced, zener diode CR1013 conducts, which activates relay K1002, discharging the filter capacitors and reducing the momentary power dissipation of the series pass transistors.

3-7. The 332A is provided with a continuously variable current limit. The current limiting transistor Q301 is normally off. When the output current begins to exceed the selected limit, the current limit drive circuit causes Q301 to begin to conduct. Conduction of Q301 bypasses part of the reference current from the voltage control resistors, thus reducing the output voltage. The LIMIT ON lamp also illuminates. When Q301 is conducting, an increase in the setting of the voltage control resistors will produce only a minor increase in the actual output voltage, because more of the reference current will pass through Q301. Thus when the LIMIT ON lamp is illuminated, the output voltage controls no longer indicate the actual output voltage.

3-8. CIRCUIT DESCRIPTIONS

3-9. 332A-401 TEMPERATURE REGULATING ASSEMBLY

3-10. The temperature regulating circuitry consists of a differential amplifier Q101, Q102; a Darlington amplifier Q103, Q104; and the associated components. One input to the differential amplifier, the base of Q102, is connected to common. Consequently, the output voltage from the collector of Q102 is proportional to the (positive) voltage appearing at the base of Q101. The resistance of R1402 is inversely proportional to temperature; therefore, as temperature decreases, the current through the base of Q101 increases, which increases the base drive of Q103. The increased voltage at the base of Q103 increases the conduction of Q103 and Q104, and thus current through the heater, R1401, increases. Because of the Darlington connection of Q103 and Q104, a small change in current at the base of Q103 results in a significant change in the current through R1401, thus providing close regulation of the oven temperature.

3-11. Current through the reference zener diode CR1402 is maintained constant by a current source consisting of Q1401, R107, R1403, and CR1401. These elements are maintained at a constant temperature for environmental stability. Resistors R108, R110, and R112 provide an adjustable dc bias on the chopper amplifier, for compensation of offset voltages at zero output.

3-12. 332A-402 DRIVER-TRIP ASSEMBLY

3-13. The 332A-402 assembly provides two primary functions: driver amplifier for the series pass transistors; and output trip due to an overvoltage or overcurrent condition. The driver portion consists of Q201, Q202, and Q203, and related components. Transistor Q201 is a common-base amplifier which provides part of the voltage gain necessary for control of the series pass transistors. Additional current gain is provided by the common-collector amplifiers Q202 and Q203. The output of Q203 is applied to the main series pass transistor.

3-14. The remainder of the 332A-402 circuit board contains the trip functions. The purpose of the trip circuit is to remove ac power from the input of the high voltage transformer, and disconnect the negative output terminal from the load, if an overvoltage or overcurrent condition exists. Transistor Q207 is used as a current

source for relays K1001 and K1202, which are held closed during normal instrument operation. Thus, relay K1201 is normally held closed, which applies ac line voltage to the primary of T2, the high voltage transformer. The current sensing resistor R201 is effectively connected from the emitter to the base of the overcurrent control transistor Q205, which is normally off. When the output current approaches 120 ma, sufficient voltage is developed across R201 to bias Q205 on. Because of the regenerative connection of Q205 to Q206, transistor Q206 also conducts and is saturated. When Q206 becomes saturated, the potential of pin 10 on the 332A-402 assembly becomes nearly the same as the potential of the + output bus, the difference being the saturation voltage of Q206 and the voltage drop across R217. This reduces the voltage to relays K1001 and K1202 below the level necessary for actuation, and these relays open. This causes relay K1201 to open, which removes ac line power from the primary side of T2. When Q206 becomes saturated, the collector-emitter voltage of Q207 rises sufficiently to illuminate DS4, the STANDBY/RESET lamp.

3-15. The overvoltage trip element is transistor Q204. The emitter of Q204 is connected to common. The base of Q204 is connected to R214, and another resistor selected by switch section S2E. The voltage trip point is selected by R3, which sets a reference bias on the base of Q204, maintaining Q204 normally cut off. However, as the output voltage increases, the voltage at the base of Q204 goes negative, so that at the selected trip voltage, forward bias is applied to the base of Q204, which causes conduction. The output of Q204 is applied to the input of Q206, which causes saturation in Q205 and Q206. The resultant opening of relay K1201 removes voltage from the primary of T2, as described in the preceeding paragraph.

3-16. 332A-403 DIFFERENTIAL AMPLIFIER ASSEMBLY

3-17. The signal from the junction of R306 and the sampling string is applied to one input of the differential amplifier, and to one input of the chopper amplifier. The gate of Q302 is the input path for ac signals: the input path for dc signals is through the chopper amplifier into the base of Q306. The chopper amplifier compares the + sense voltage to the summing junction voltage, and provides an amplified error signal proportional to the difference. This error signal is applied to the base of Q306, the input path for dc through the differential amplifier. The differential amplifier provides an output that is proportional to the difference between the ac input signal and the amplified error signal from the chopper amplifier. Providing the separate input path for ac provides more rapid regulation of the output voltage for ac changes. Use of the field-effect transistor Q302 provides higher input impedance and low noise. Transistor Q308 is a current source for one stage of the differential amplifier. Use of the current source provides high gain and good common mode rejection at the input of the amplifier. The compound connection of Q304 to Q305, and of Q306 to Q307, provides high input impedance and minimizes temperature effects. The output signal from the collector of Q310 is applied to the input of Q311, a common-collector amplifier. Transistor Q311 provides impedance matching between the high output impedance of Q310 and the low input impedance of Q201, to which the error signal is applied for further amplification.

3-18. 332A-404 CHOPPER AMPLIFIER ASSEMBLY

3-19. The chopper amplifier consists of a chopper modulator/demodulator, and essentially 2 stages of amplification. The chopper modulator samples the difference between the summing junction voltage and the offset voltage. The resulting square wave is applied to the gate of Q401. Transistor Q402 amplifies the output of Q401. Transistors Q403 and Q404 are dc coupled amplifiers, having feedback from the collector of Q404 to the emitter of Q403. Transistor Q405 is a split-load phase inverter, which provides two essentially identical square-waves, differing in phase by 180°. The two square waves are demodulated by the chopper, G401, and filtered by R424, R425, and C411 to provide the amplified dc error signal. The filtered output is applied to one input of the main differential amplifier.

3-20. 332A-405 AUXILIARY SUPPLY ASSEMBLY

3-21. The 332A-405 circuit board contains two regulated auxiliary supplies. Filtered, unregulated, dc voltage for the +25 volt supply is provided by CR501 through CR504, C501, C502, and R501. Transistors Q504 and Q505 form a differential amplifier. The input to Q505 is the reference voltage of CR506. The input to Q504 is a sample of the auxiliary supply output voltage taken from R505, R506, and R507. The output from the collector of Q504 represents the amplified difference between the reference voltage and the output voltage sample. The output from Q504 is applied to the input of the Darlington-connected transistors Q502, Q503, which varies the conduction of Q502 and Q503 so as to maintain the output voltage constant. Transistor Q501 functions as a constant current source for Q504, which provides a large dynamic collector load resistance for high gain. Since the +25 volt auxiliary supply is applied to the zener reference circuit, stability of the +25 volts affects the stability of the instrument, and good regulation is necessary.

3-22. Filtered, unregulated, dc voltage for the -15 volt auxiliary supply is provided by CR507 through CR510, R510, and C507. Transistors Q507 and Q508 are connected as a differential amplifier, the output at the collector of Q507 being proportional to the difference between the -15 volt output and the voltage at the base of Q508. Consequently, any variation of the -15 volt auxiliary voltage varies the voltage at the base of Q508, which is amplified and applied to the base of Q506. The conduction of Q506 is thus controlled to maintain the -15 volt auxiliary voltage constant.

3-23. 332A-406 AUXILIARY CURRENT LIMITER ASSEMBLY

3-24. Rectified voltage for the +35 volt auxiliary supply and for the -35 volt auxiliary supply is provided by CR601 through CR604. The unregulated dc voltage for the +35 volt supply is filtered by R601 and C601. The series pass transistor is Q601. The difference between the

36 volt reference voltage of CR606 and the 35 volt output provides the base bias for Q601. Variation in the +35 volts, or in the unregulated dc voltage, changes the conduction of Q601, so that the +35 volts is maintained constant. The -35 volt supply functions in the same manner as the +35 volt supply, except that the series pass transistor is a pnp unit and polarities are, of course, reversed.

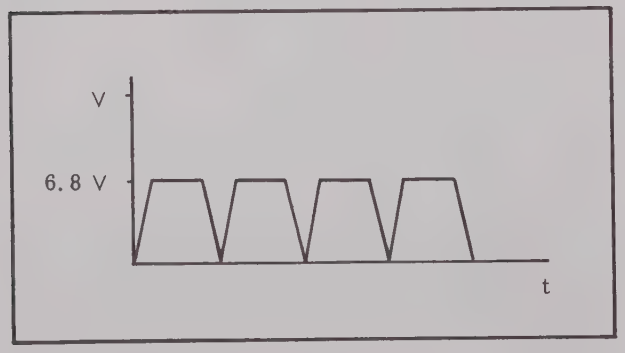
3-25. The current sensing resistor for operation of the current limiting circuit is R201, which is connected between pin 10 and common of the 332A-406 board. The base of Q603 is connected through CR608 to the + output bus. The emitter of Q603 is connected to the wiper of the current limit variable resistor R4, which provides a variable offset voltage for the input of Q603. Consequently, the base-emitter junction of Q603 is effectively across the current sensing resistor, with a variable offset provided by R4. Transistor Q603 is normally biased off; however, when the output current exceeds the selected limit, Q603 becomes biased on. This turns on Q604 and Q605. The voltage change at the emitter of Q605 turns on Q301. Conduction of Q301 robs part of the sampling-string current. The reduction in sampling string current reduces the output voltage. The voltage change at the emitter of Q605 which turned on Q301 also turns on Q606 and Q607, which are connected as a regenerative pair, or SCR. Conduction of this regenerative pair illuminates DS5, the LIMIT ON indicator.

3-26. 332A-408 REFERENCE BOARD ASSEMBLY

3-27. The reference board provides the three operating currents to the voltage control resistors required for the three output ranges. A reference voltage of approximately 6.3 volts is provided by CR1402. This voltage is reduced by R801 and R803 to approximately 6.02 volts. Resistor R809 provides 1 ma for operation on the 1000 volt range. Resistor R807 provides 0.1 ma for operation on the 100 volt range. Resistor R805 provides 0.01 ma for operation on the 10 volt range.

3-28. 332A-411 SERIES PASS ASSEMBLY

3-29. Diodes CR1101 through CR1104, C1102, and R1101 provide filtered, unregulated, dc voltage of +300 volts. Diodes CR1105 through CR1108, CR1109, and R1104 through R1106 provide a dc voltage of +6.8 volts. Due to the presence of zener diode CR1109, the waveform of the +6.8 volts is that of a clipped, full-wave-rectified, 60 Hz sine wave, as follows:



3-30. The series pass transistors are Q1102 through Q1105, which are connected in series. The error signal from the main differential amplifier is applied to the driver amplifier, Q201, Q202, and Q203, and then to the base of Q1105. The conduction of Q1105 is varied by this amplified error signal to maintain a constant load voltage. Transistors Q1102, Q1103, and Q1104 are normally saturated by the base current supplied by the +300 volt source; consequently, the entire voltage drop required for regulation is across Q1105. The voltage across Q1105 is usually about 50 volts. If the voltage across Q1105 rises above 300 volts, the base current to Q1102, Q1103, and Q1104 will be cut off, and these transistors will come out of saturation to share the required voltage drop. The 100K resistors from collector to base, and from base to emitter of the following transistor, will divide the excess voltage drop equally across the three transistors. As soon as the total voltage drop decreases below 300 volts, the three transistors will again be biased to saturation, and Q1105 will absorb the entire voltage.

3-31. Transistor Q1101 is a unijunction oscillator which furnishes a turn-off pulse to the preregulator circuit. When the charge on C1104 equals a critical level, as determined by the biasing from base-1 to base-2 of Q1101, the unijunction will conduct, delivering a pulse of current to the primary of T1101. The point in the line frequency cycle at which the unijunction conducts will be determined by the charging rate of C1104, which is in turn determined by the voltage drop across the series pass transistors. Reference diode CR1111 determines the minimum voltage drop across the series pass transistors which will charge C1104. The unijunction will conduct at least once every half cycle when the clipped sinusoidal voltage applied to base 2 goes to zero. This is required to reset the timing sequency each half cycle.

3-32. 332A-412 PREREGULATOR ASSEMBLY

3-33. The control element for the preregulator is a diode quad, CR1205 through CR1208, which is bridged by an npn transistor, Q1207. This bridged quad is in series with the primary of the high voltage transformer, T2. Primary current will flow only when Q1207 is conducting. Transistor Q1207 is normally turned on at the beginning of each half-cycle of line frequency, and is turned off during the cycle at a time determined by the output pulse from the unijunction transistor Q1101. The preregulator circuit thus controls the current into the high voltage transformer so that the voltage drop across the series pass transistors will remain constant.

3-34. The preregulator operates as follows: at the beginning of each half cycle, Q1204 is turned on by the positive-going voltage +v, which is a full-wave-rectified sine wave. Conduction of Q1204 saturates Q1205, Q1206, and Q1207, the preregulator transistor, which allows current to flow in the transformer primary. Pulses from transformer T1101 are applied to the base of Q1201. This turns on Q1201, which also turns on Q1202 because of the regenerative connection of Q1202 and Q1201. Conduction of Q1201 and Q1202 shuts off Q1204, Q1205, Q1206, and Q1207. The waveform of - v at the emitter of Q1201 is that of a full-wave-rectified 60 Hz wave,

without filtering. Consequently, after Q1201 and Q1202 are triggered into conduction, these two transistors remain saturated until the end of that particular half cycle. Therefore, after transistor Q1207 is triggered off, it is held off for the remainder of that half cycle. Transistor Q1203 is connected to a current-sensing resistor in series with Q1207. Excess bridge current causes Q1203 to conduct, which applies an input to Q1201, reducing conduction through Q1207 in the same way as described above. This provides current limiting in the preregulator as a safety feature.

3-35. 332A-420 TIME DELAY ASSEMBLY

3-36. The purpose of the time delay is to provide a short interval for the auxiliary voltages to rise to nominal value, thus insuring that the control amplifiers are working when the dc high voltage is available, providing better control during turn-on. The time delay momentarily holds open relays K1001 and K1202, which prevents closure of relay K1201. The time delay is approximately 3 seconds, which is more than sufficient for the auxiliary voltages to rise. Diodes CR2001 and CR2002 provide full-wave rectified dc from a center-tapped transformer winding. When the POWER switch is in the STANDBY/RESET position, a small current flows through K2001, R2004, and C2001. This current, though too small to actuate K2001, charges capacitor C2001. When the voltage of C2001 equals the voltage necessary to turn on Q2001, this SCR conducts, and sufficient current flows to actuate relay K2001. Contacts K2001 open, and remove the grounding circuit from K1001 and K1202, thus permitting actuation of relays K1001, K1202, and K1201. AC line voltage is then applied to the bridge preregulator circuit.

SECTION IV

MAINTENANCE

4-1. INTRODUCTION

4-2. Maintenance of the 332A Voltage Calibrator should consist primarily of periodic cleaning and calibration. However, to determine if the instrument is within specifications, the instruments performance can be checked just before calibration by using the performance tests in paragraph 4-5. Information on troubleshooting is included in paragraph 4-10. Calibration procedures are given in paragraph 4-29.

Note!

On instruments having serial numbers 123 through 332, the X position of voltage dials 2 through 7 was labeled 10. In describing voltage dial settings in this Section of the manual, the dial setting is given in parenthesis for the earlier instruments, as follows; 10XX.XXXX (or 10 10 10. 10 10 10 10)

4-3. TEST EQUIPMENT

4-4. Figure 4-1 lists the equipment recommended for performance testing, troubleshooting, and calibration. If the recommended equipment is not available, other equipment which meets the required specifications may be used.

4-5. PERFORMANCE TESTING

4-6. The following tests are designed to compare the instruments performance to the specifications. The tests may be used during maintenance, or for receiving inspection. It is recommended that these performance tests be performed just before calibration of the instrument. When used in this way, the performance tests provide a history of the characteristics of each instrument. Just prior to calibration, the instrument should be within specifications; if not, troubleshooting should usually be performed to correct the cause of error before calibration. Analysis of performance test results in conjunction with troubleshooting will help to find the cause of any trouble.

4-7. LINE REGULATION

a. Connect the autotransformer to the line, and connect the 332A to the autotransformer. Set the autotransformer for 115 volts output (or 230 volts if the instrument is so wired).

b. Set the front-panel controls of the 332A as follows:

POWER	STANDBY/RESET
METER	VOLTAGE
VOLTAGE TRIP	120%
CURRENT LIMIT	60
VOLTAGE RANGE	10
Voltage dials	zero

c. Connect the 885A to the OUTPUT terminals of the 332A, and set the 885A for negative polarity.

d. Connect a 20 ohm ±5%, 1/2 w load resistor to the 332A OUTPUT terminals.

e. Set the voltage dials to 1.000000 volts.

f. Vary the input voltage from 115 volts to 103 volts. The 885A should indicate a voltage change of less than 25 uv.

g. Vary the input voltage from 115 volts to 127 volts. The 885A should indicate a voltage change of less than 25 uv.

h. Change the load resistor from 20 ohms to 200 ohms ±5%, 1 w, and set the voltage dials to 10.00000.

i. Vary the input voltage from 103 volts to 115 volts. The 885A should indicate a voltage change of less than 50 uv.

j. Vary the input voltage from 115 volts to 127 volts. The 885A should indicate a voltage change of less than 50 uv.

k. Set the VOLTAGE RANGE switch to 100, and set the voltage dials to 10.00000.

l. Vary the input voltage from 103 volts to 115 volts. The 885A should indicate a voltage change of less than 50 uv.

m. Vary the input voltage from 115 volts to 127 volts. The 885A should indicate a voltage change of less than 50 uv.

RECOMMENDED EQUIPMENT	SPECIFICATIONS REQUIRED	USE
VTVM, RCA Voltohmyst, or equivalent	DC Accuracy of ±3%. Input Impedance of 10M	Troubleshooting
Autotransformer, General Radio Model W5MT3, or equivalent. (Model W5HMT for 230 v instruments.)	Output of 103 to 127 volts ac. (Output of 207 to 253 volts ac for 230 volt instruments.)	Performance testing
DC Differential Voltmeter, Fluke Model 885A, or equivalent	DC Accuracy of ±0.0025% 100 uv null detector	Troubleshooting Calibration Performance Testing
RMS Voltmeter, Fluke Model 910A, or equivalent	Measurement of non-sinusoidal waves at 20 uv to 40 uv level.	Performance testing
Preamplifier, Gain of 60 (±3) db, Bandwidth of 10 Hz to 10 kHz		
Oscilloscope, Tektronix Type 541, or equivalent	General purpose use, Sensitivity of 1v/cm, Bandwidth of 450 kHz	Troubleshooting
DC Power Supply, general purpose	Adjustable output of 0 to 10 vdc, Accuracy of ±5%	Troubleshooting
DC Null Detector, Fluke Model 845AB, or equivalent	Must be capable of providing an output with an accuracy of at least ±(0.001% +2 uv)	Calibration
Voltage Reference Divider, Fluke Model 750A, calibrated to maintain an accuracy of ±0.0006%, or equivalent		
Standard Cells, with enclosure		
Load resistors	20 ohms ±5%, 1/2 w 200 ohms ±5%, 1 w 2K ±5%, 5 w 20K ±5%, 50 w 8K ±5%, 20 w	Performance Testing

Figure 4-1. TEST EQUIPMENT REQUIRED

n. Change the load resistor from 200 ohms to 2K ±5%, 5 w, and set the voltage dials to 100.0000.

o. Vary the input voltage from 103 volts to 115 volts. The 885A should indicate a voltage change of less than 500 uv.

p. Vary the input voltage from 115 volts to 127 volts. The 885A should indicate a voltage change of less than 500 uv.

q. Set the VOLTAGE RANGE switch to 1000, and set the voltage dials to 100.0000.

r. Vary the input voltage from 103 volts to 115 volts. The 885A should indicate a voltage change of less than 500 uv.

s. Vary the input voltage from 115 volts to 127 volts. The 885A should indicate a voltage change of less than 500 uv.

t. Change the load resistor from 2K to 20K ±5%, 50 w, and set the voltage dials to 1000.0000.

u. Vary the input voltage from 115 volts to 103 volts. The 885A should indicate a voltage change of less than 5 mv.

v. Vary the input voltage from 115 volts to 127 volts. The 885A should indicate a voltage change of less than 5 mv.

4-8. LOAD REGULATION

a. Connect the autotransformer to the line, and connect the 332A to the autotransformer. Set the autotransformer for 103 volts output.

b. Set the front-panel controls on the 332A as follows:

POWER	STANDBY/RESET
METER	VOLTAGE
VOLTAGE TRIP	120%
CURRENT LIMIT	60
VOLTAGE RANGE	10
Voltage dials	zero

c. Connect the 885A to the SENSE terminals.
d. Set the voltage dials to 1.000000, and set the POWER switch to ON.
e. Record the voltage indicated by the 885A.
f. Connect the 20 ohm load resistor to the OUTPUT terminals. The 885A should indicate a voltage change of less than 25 uv.
g. Remove the 20 ohm load resistor, and set the voltage dials to 10.00000. Record the voltage indicated by the 885A.
h. Connect the 200 ohm load resistor to the OUTPUT terminals. The 885A should indicate a voltage change of less than 50 uv.

i. Remove the 200 ohm resistor, and set the VOLTAGE RANGE switch to 100. Set the voltage dials to 10.00000. Record the voltage indicated by the 885A.
j. Connect the 200 ohm load resistor to the OUTPUT terminals. The 885A should indicate a voltage change of less than 50 uv.
k. Remove the 200 ohm resistor, and set the voltage dials to 100.0000. Record the voltage indicated by the 885A.
l. Connect the 2K load resistor to the OUTPUT terminals. The voltage change indicated by the 885A should be less than 500 uv.
m. Remove the 2K load resistor, and set the VOLTAGE RANGE switch to 1000. Set the voltage dials to 100.0000. Record the voltage indicated by the 885A.
n. Connect the 2K load resistor to the OUTPUT terminals. The 885A should indicate a voltage change of less than 500 uv.
o. Remove the 2K load resistor. Set the voltage dials to 1000.0000. Record the voltage indicated by the 885A.
p. Connect the 20K load resistor to the OUTPUT terminals. The 885A should indicate a voltage change of less than 5 mv. Disconnect the 20K resistor.

4-9. RIPPLE

a. Connect the preamplifier to the output of the 332A, and connect the 910A RMS Voltmeter to the output of the preamplifier.
b. Set the front-panel controls on the 332A as follows:

POWER	STANDBY/RESET
METER	VOLTAGE
VOLTAGE TRIP	120%
CURRENT LIMIT	60
VOLTAGE RANGE	10
Voltage dials	zero

c. Set the POWER switch to ON. Ripple indicated by the 910A should not exceed 20 uv rms.
d. Set the voltage dials to 10.00000. Ripple indicated by the 910A should not exceed 20 uv rms.
e. Connect the 200 ohm load resistor to the OUTPUT terminals. Ripple indicated by the 910A should not exceed 20 uv rms. Disconnect the 200 ohm resistor.
f. Set the voltage dials to zero, and set the VOLTAGE RANGE switch to 100. Ripple indicated by the 910A should not exceed 30 uv rms.
g. Set the voltage dials to 100.0000. Ripple indicated by the 910A should not exceed 30 uv rms.
h. Connect the 2K load resistor to the OUTPUT terminals. Ripple indicated by the 910A should not exceed 30 uv rms. Disconnect the 2K load resistor.
i. Set the voltage dials to zero, and set the VOLTAGE RANGE switch to 1000. Ripple indicated by the 910A should not exceed 40 uv rms.
j. Set the voltage dials to 400.0000. Ripple indicated by the 910A should not exceed 40 uv rms.
k. Connect the 8K load resistor to the OUTPUT terminals. Ripple indicated by the 910A should not exceed 40 uv rms.

4-10. TROUBLESHOOTING

4-11. PERIODIC MAINTENANCE

4-12. Periodic maintenance consists primarily of occasional cleaning to remove dust, grease, and other contamination. Since the Voltage Calibrator is completely enclosed, having no fans, the need for cleaning is reduced. Special care has been taken to prevent leakage. The voltage range switch and the seven voltage control switches are vacuum impregnated with silicon oil. The circuit board holding the resistors for the first voltage dial is isolated from the chassis by means of polyethelene grommets. Printed circuit boards are coated with a moisture sealant.

4-13. The 332A is equipped with an extender board which aids troubleshooting. The extender board may be inserted between the circuit boards and their chassis connectors. When measuring voltages on the circuit boards, it is recommended that the major portion of the voltage probe be wrapped with insulating tape. This will reduce the possibility of damaging a transistor due to an accidental short circuit. Transistors in the 332A are mounted on the circuit boards by transistor sockets. This is an aid to measuring voltages, as well as providing for easy replacement of the transistors. A troubleshooting chart is given in Figure 4-2.

4-14. CLEANING

CAUTION!

Avoid touching the polyethelene grommets. Contamination can cause excessive electrical leakage.

a. Remove loose contamination from the instrument with low-pressure, clean, dry air. Pay particular attention to the front panel binding posts, binding post wiring, switches, and the polyethelene grommets.
b. Clean the polyethelene grommets, binding posts, and the front panel with anhydrous ethyl alcohol, or an aerosol can of Freon TF Degreaser (Miller-Stephenson Chemical Co., Inc.). When necessary, a clean cloth or cotton swab can also be used.
c. When necessary, clean the exposed dielectric surfaces of switches with anhydrous alcohol, using a small, stiff-bristled brush which has been wrapped with a clean cloth to prevent saturating the switch contacts. After cleaning, recoat the exposed dielectric surfaces with silicon fluid. This will prevent leakage along these surfaces due to moisture.

SYMPTOM	PROBABLE CAUSE	REMEDY
Constant percentage error in output voltage	Out-of-calibration	Recalibrate according to para. 4-29.
Percentage error over part of voltage range	Defective wirewound resistor in one of the voltage dials.	Set output voltage to maximum and decrease one position at a time until the error disappears. The defective resistor will be found in the last switch position in which the error was noted.
	Voltage dial ratio out of tolerance	Recalibrate according to para. 4-33.
Output erratic over part of range	Same as percentage error over part of range.	
	Defective resistor on 408 circuit board	Connect an ohmmeter between the OUTPUT terminals. Measure the resistance of the sampling string and compare to the schematic diagram.
	Open sample resistor or switch.	Test and replace if necessary.
Loss of control	Defective diode or transistor	Check diodes and transistors.
Poor line regulation	Poor regulation of auxiliary supplies	Measure regulation of auxiliary supplies. Repair if necessary.
Poor load regulation	Defective component on 332A-404 circuit board	Check and repair as necessary.
	Incorrect use of SENSE terminals.	Review useage of remote sensing, and use if possible.
Oscillation in output	Defective component on 402, 403, 404, or 411 circuit boards	Check and repair as necessary.
	Oscillation in auxiliary supplies.	Test and repair if necessary.
Excessive drift	Defective Q1401, CR1401, or CR1402.	Test circuit and repair if necessary.
Excessive ripple	Excessive ripple in auxiliary supplies.	Test and repair if necessary.
	Defective component on 332A-403 circuit board.	Test and repair if necessary.
Fuse blows repeatedly	Shorted C1301, C1302, C1303, C1603, CR1209, or Q1207.	Test and replace if necessary.

Figure 4-2. TROUBLESHOOTING CHART

CAUTION!

Do not use Metriclene, acetone, lacquer thinner, or any ketone, since they will react with the Lexan switch rotors and spacers. Also, do not saturate the switch contacts, which have been permanently lubricated.

4-15. AUXILIARY SUPPLY VOLTAGES

4-16. Check the voltage of the auxiliary supplies as follows:

a. Remove the cover of the 332A.
b. Connect the common side of the 885A voltmeter to the + SENSE terminal.

c. Set the front-panel controls on the 332A as follows:

POWER	STANDBY/RESET
METER	VOLTAGE
VOLTAGE TRIP	120%
CURRENT LIMIT	60
VOLTAGE RANGE	100
Voltage dials	50.00000

d. Using the extender board, connect the 885A between + SENSE and the following points, and measure the corresponding voltages:

CAUTION!

The 332A has interlocks which switch the instrument to standby/reset operation when a circuit board is removed. However, to prevent possible damage due to transient voltages when the circuit board is replaced, set the POWER switch to OFF before removing or replacing a circuit board.

CIRCUIT BOARD	MEASURED VOLTAGE
332A-405, pin 9	-15 (±1) volts dc
332A-406, pin 1	-36 (±3) volts dc
332A-406, pin 3	+36 (±3) volts dc
332A-411, collector of Q1105	+160 (approx.) volts dc
332A-401, collector of Q104	+32.5 (±2.5) volts dc (after 10 minute warmup)

e. Connect the 885A between the + SENSE terminal and circuit board 332A-405, pin 10.

f. Adjust R505, if necessary, so that the 885A indicates +25 (±0.2) volts dc.

Note!

The location of calibration and troubleshooting adjustments is given in Figure 4-3.

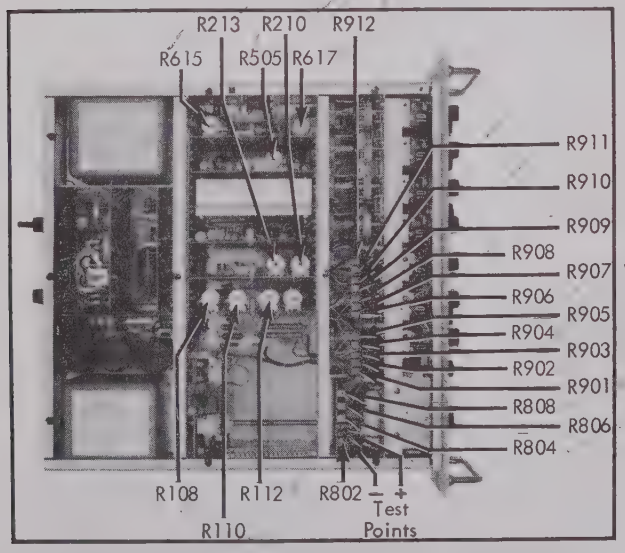


Figure 4-3. LOCATION OF ADJUSTMENT

4-17. UJT OSCILLATOR OPERATION

a. Connect an oscilloscope across R1108, on circuit board 332A-411. Set the oscilloscope sweep speed to 1 msec/cm, and set the vertical sensitivity to 1 v/cm.

b. Set the front-panel controls on the 332A as follows:

POWER	STANDBY/RESET
METER	VOLTAGE
VOLTAGE TRIP	120%
CURRENT LIMIT	60
VOLTAGE RANGE	100
Voltage dials	50.00000

c. The LIMIT ON and STANDBY/RESET lamps should illuminate. The oscilloscope should indicate pulses having an amplitude of 2.5 (±1.5) volts peak-to-peak. The pulses indicate correct operation of the unijunction oscillator, and indirectly indicate correct operation of the +300 volt auxiliary supply.

4-18. AMPLIFIER RESPONSE

4-19. The amplifier can be tested for correct response as follows:

a. Perform the steps of paragraph 4-17.

b. Set the POWER switch to ON. If the amplifier is operating correctly, the LIMIT ON and STANDBY/RESET lamps will extinguish and the pulses from the unijunction oscillator will stop.

c. Disconnect the oscilloscope.

4-20. FEEDBACK LOOP RESPONSE

4-21. The feedback loop can be tested for correct response as follows:

a. Remove the 332A-412 circuit board.

b. Set the front-panel switches on the 332A as follows:

POWER	STANDBY/RESET
METER	VOLTAGE
VOLTAGE TRIP	120%
CURRENT LIMIT	60
VOLTAGE RANGE	10
Voltage dials	5.000000

c. Connect the general purpose power supply to the OUTPUT terminals, observing to match the output polarities.

d. Connect the 885A from the + SENSE terminal to circuit board 332A-402, pin 4. Use the extender board.

e. Set the output of the general purpose power supply to 4.5 volts.

f. Set the POWER switch to ON.

g. Vary the output of the general purpose power supply from +4.5 volts to +5.5 volts. The voltage indicated by the 885A should vary from approximately +0.6 volts to -0.6 volts, respectively.

h. Set the VOLTAGE RANGE switch to 100, and set the voltage dials to 05.00000.

i. Repeat step g.

j. Set the VOLTAGE RANGE switch to 1000, and set the voltage dials to 005.0000.

k. Repeat step g.
l. Set the POWER switch to OFF, and replace the 332A-412 circuit board.

4-22. PREREGULATOR DRIVE CHECK

4-23. The drive circuit for the preregulator transistors can be tested for correct operation as follows:

a. Connect the Voltohmyst from the base (yellow) to the emitter (blue) of Q1207, the Westinghouse power transistor on the 332A-412 circuit board. The voltmeter common lead should be connected to the emitter. Set the Voltohmyst to the -1.5 volt dc range.
b. Set the front-panel switched on the 332A as follows:

POWER	STANDBY/RESET
METER	VOLTAGE
VOLTAGE TRIP	120%
CURRENT LIMIT	60
VOLTAGE RANGE	100
Voltage dials	050.0000

c. The Voltohmyst should indicate -0.6 volts, approximately.
d. Set the POWER switch to ON. The Voltohmyst should indicate +0.6 volts, approximately.
e. Set the POWER switch to STANDBY/RESET, and remove the Voltohmyst.

Note!

For those instruments using two Delco power transistors in place of the Westinghouse power transistor Q1207, the preceeding steps a. through e. should read as follows:

a. Connect the Voltohmyst from the base to the emitter of either Delco power transistor on the 332A-412 circuit board. Voltmeter common should be connected to the emitter. Set the Voltohmyst to the +1.5 volt dc range.
b. Set the front-panel controls on the 332A as follows:

POWER	STANDBY/RESET
METER	VOLTAGE
VOLTAGE TRIP	120%
CURRENT LIMIT	60
VOLTAGE RANGE	100
Voltage dials	050.0000

c. The Voltohmyst should indicate +0.6 volts, approximately.
d. Set the POWER switch to ON. The Voltohmyst should indicate -0.3 volts, approximately.
e. Set the POWER switch to STANDBY/RESET, and remove the Voltohmyst.

4-24. CALIBRATION OF PANEL METER

a. Set the front-panel switches on the 332A as follows:

POWER	STANDBY/RESET
METER	VOLTAGE
VOLTAGE TRIP	120%
CURRENT LIMIT	60
VOLTAGE RANGE	100
Voltage dials	100.0000

b. Set the POWER switch to ON. Adjust R210 so that the panel meter indicates 100 (±1) volts.
c. Check the accuracy of the meter indication at other output voltages, as desired. The meter indication should be within ±3% of the actual output voltage.

4-25. ALIGNMENT OF VOLTAGE TRIP

a. Set the front-panel switches on the 332A as follows:

POWER	ON
METER	VOLTAGE
CURRENT LIMIT	60
VOLTAGE RANGE	100
Voltage dials	60.00000

b. Set R213 fully counterclockwise, and turn the VOLTAGE TRIP control to the 12 o'clock position.
c. Rotate R213 clockwise until the trip circuit actuates.
d. Turn the VOLTAGE TRIP control fully clockwise.
e. Set the voltage dials to 111.0000.
f. Slowly turn the VOLTAGE TRIP control counterclockwise. The trip circuit should actuate at about 30° from the clockwise end.
g. Repeat steps d. and f. with the output set to 11.00000 volts, and with the output set to 10XX.X000 (or 10 10 10.10 000).

4-26. ALIGNMENT OF CURRENT LIMIT

a. Set the front-panel switches on the 332A as follows:

POWER	STANDBY/RESET
METER	CURRENT
VOLTAGE TRIP	120%
CURRENT LIMIT	60
VOLTAGE RANGE	100
Voltage dials	50.00000

b. Short the OUTPUT terminals.
c. Set the POWER switch to ON.
d. Adjust R617, if necessary, so that meter indicates 60 ma.
e. Set the CURRENT LIMIT control to zero, and adjust R615, if necessary, so that the meter indicates 1 ma.
f. Set the CURRENT LIMIT control to 60. The meter should indicate 60 ma. If not, repeat steps d. and e.

4-27. MECHANICAL DRUM ADJUSTMENTS

4-28. Occasionally it may be necessary to align the voltage dial drums so that the numbers are vertically centered in the readout windows. Each dial is an independent unit. Proceed as follows:

a. Remove the cover of the instrument.
b. Set each dial to zero.
c. If the numbers of a dial are not vertically centered in the readout window, use a hex key to loosen the drive gear on the switch shaft of that particular dial, and center the number 0 in the readout window. Access to the drive gear is from the bottom of the instrument.

4-29. CALIBRATION

4-30. The stability of the 332A is specified for a six month period. Calibration may be easily checked at more frequent intervals, if desired. The equipment required for calibration is listed in Figure 4-1. Calibration of the 332A consists essentially of four steps: (1) Setting the reference voltage. (2) Setting the zero output of each range. (3) Setting the voltage dials for ratio accuracy, and (4) Setting the range resistors for absolute output accuracy. The instrument should be allowed to warmup for a minimum of 60 minutes in an environment of 23 (±1)° C, 30% to 60% relative humidity. A constant line voltage should be used.

4-31. REFERENCE VOLTAGE ADJUSTMENT

a. Set the front-panel switches on the 332A as follows:

POWER	ON
METER	VOLTAGE
VOLTAGE TRIP	120%
CURRENT LIMIT	60
VOLTAGE RANGE	1000
Voltage dials	00X. 0000 (or 0010. 0000)

b. Connect the 885A to the REF MONITOR test points accessible through the top cover.

c. Adjust R802 so that the 885A indicates 6.02 (±0. 000020) volts.

4-32. ADJUSTMENT OF ZERO OUTPUT

a. Connect the 845AB Null Detector to the OUTPUT terminals. Set the 845AB for reduced full-scale sensitivity.

b. Set the front-panel controls on the 332A as follows:

POWER	ON
METER	VOLTAGE
VOLTAGE TRIP	120%
CURRENT LIMIT	60
VOLTAGE RANGE	1000
Voltage dials	000. 0000

c. Adjust R112, if necessary, so that the 845AB indicates 0 (±0. 000002) volts. Sensitivity of the 845AB may be increased as null is approached.

d. Set the VOLTAGE RANGE switch to 100.

e. Adjust R110, if necessary, so that 845AB indicates 0 (±0. 000002) volts.

f. Set the VOLTAGE RANGE switch to 10.

g. Adjust R108, if necessary, so that 845AB indicates 0 (±0. 000002) volts.

4-33. ADJUSTMENT OF RATIO ACCURACY

WARNING!

The inner chassis is at the same potential as the + OUTPUT terminal, and consequently, may be as much as 1100 volts above ground. Avoid contact with the inner chassis.

a. Connect the 885A to the OUTPUT terminals, with the voltmeter common connected to the positive output. Do not connect the GUARD or chassis ground terminals.

b. Set the VOLTAGE RANGE switch to 1000, and set the voltage dials to 00X. 0000 (or 0010. 0000) volts. Using the 10 volt range of the 885A, record the output voltage of the 332A within 5 uv.

c. Set the second voltage dial to 1, and set the third voltage dial to 0. Adjust R907 so that the voltage indicated by the 885A is within 5 uv of the voltage measured in step b.

d. Repeat steps b. and c. according to the following, Table 1:

TABLE 1

STEP	POSITION OF SECOND DIAL	POSITION OF THIRD DIAL	
e.	1	X (or 10)	Record voltage indication of 885A within 10 uv.
f.	2	0	Adjust R908 so that 885A indication is within 10 uv of step e.
g.	3	X (or 10)	Record voltage indication of 885A within 10 uv
h.	4	0	Adjust R909 so that 885A indication is within 10 uv of step g.
i.	5	X (or 10)	Record voltage indication of 885A within 10 uv.
j.	6	0	Adjust R910 so that 885A indication is within 20 uv of step i.
k.	7	X (or 10)	Record voltage indication of 885A with 20 uv.
l.	8	0	Adjust R911 so that 885A indication is within 20 uv of step k.
m.	9	X (or 10)	Record voltage indication of 885A within 20 uv.
n.	X (or 10)	0	Adjust R912 so that 885A indication is within 20 uv of step m.

o. Set all voltage dials to zero, and set the VOLTAGE RANGE switch to 100.

p. Set the second voltage dial to X (or 10), and record the voltage indicated by the 885A within 5 uv.

q. Set the first voltage dial to 1, and set the second voltage dial to zero. Adjust R901 so that the voltage indicated by the 885A is within 5 uv of the voltage measured in step p.

r. Repeat steps p. and q. according to the following, Table 2:

TABLE 2

STEP	POSITION OF FIRST DIAL	POSITION OF SECOND DIAL	
s.	1	X (or 10)	Record voltage indication of 885A within 10 uv.
t.	2	0	Adjust R902 so that 885A indication is within 10 uv of step s.
u.	3	X (or 10)	Record voltage indication of 885A within 10 uv.
v.	4	0	Adjust R903 so that 885A indication is within 10 uv of step u.
w.	5	X (or 10)	Record voltage indication of 885A within 10 uv.
x.	6	0	Adjust R904 so that 885A indication is within 20 uv of step w.
y.	7	X (or 10)	Record voltage indication of 885A within 20 uv.
z.	8	0	Adjust R905 so that 885A indication is within 20 uv of step y.
aa.	9	X (or 10)	Record voltage indication of 885A within 20 uv.
ab.	10	0	Adjust R906 so that 885A indication is within 20 uv of step aa.

4-34. ADJUSTMENT OF ABSOLUTE ACCURACY

4-35. The range resistors should be adjusted for absolute accuracy after the sampling string has been adjusted for linearity. It is also desirable to check the instrument for absolute output accuracy at more frequent intervals than checking the ratio accuracy, due to the possibility that the reference zener diode may shift its operating voltage slightly. Proceed as follows:

a. Connection of the calibrating equipment is illustrated in Figure 4-4. Connect the 332A OUTPUT to the output voltage terminals of the 750A. Connect the standard cell to the std. cell terminals, and connect the 845AB to the null detector terminals, of the 750A. Use the remote sensing feature of the 332A. Set the standard cell dials to the correct voltage, and set the galvanometer switch to open. Set the 845AB for reduced sensitivity.

b. Set the 750A output voltage switch to 100 volts.

CAUTION!

For improved accuracy, the output terminals of the 750A are being utilized as input terminals. To prevent possible damage to the 750A, set the CURRENT LIMIT control for 2 ma.

c. Set the front-panel controls on the 332A as follows:

POWER	ON
METER	VOLTAGE
VOLTAGE TRIP	120%
CURRENT LIMIT	2 ma
VOLTAGE RANGE	1000
Voltage dials	100.0000

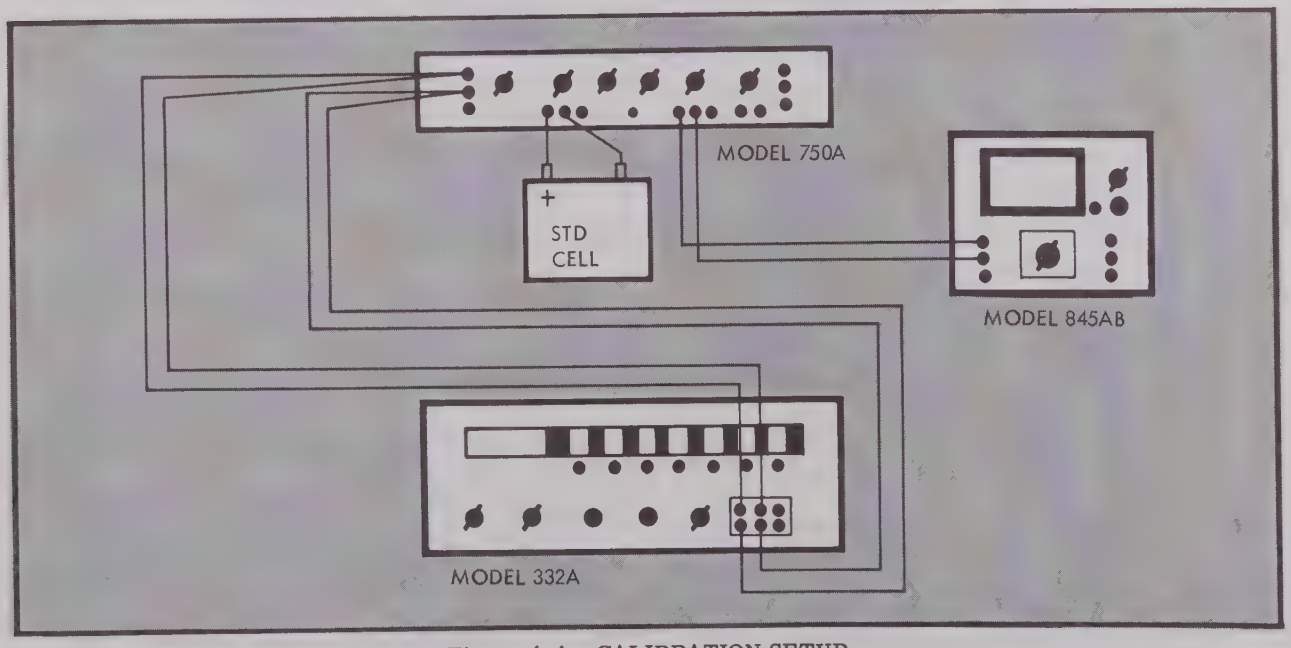


Figure 4-4. CALIBRATION SETUP

d. Adjust R808 so that the 845AB indicates 0(±0.000001) volt. Sensitivity of the 845AB may be increased as null is approached.

e. Set the std. cell switch to open, and set the VOLTAGE RANGE switch to 100. Set the voltage dials to 100.00000.

f. Set the std. cell to locked. Adjust R806 so that the 845AB indicates 0(±0.000001) volt. Sensitivity of the 845AB may be increased as null is approached.

g. Set the std. cell switch to open, and set the VOLTAGE RANGE switch to 10. Set the voltage dials to 10.000000. Set the output voltage switch of the 750A to 10.

h. Set the std. cell switch to locked. Adjust R804 so that the 845AB indicates 0(±0.000001) volt. Sensitivity of the 845AB may be increased as null is approached.

i. Because of a slight interaction of R808, R806, and R804, repeat steps b. through h.

j. After completion of the preceeding alignment, it may be informative to compare the output of the 332A to the output of the 750A. This can be done with the same equipment connections utilized in the preceeding calibration, by merely setting the voltage dials of the 332A and the voltage switch of the 750A to corresponding positions, and noting the deflection of the null detector. Voltages so checked must be within 10 ppm of nominal. The following voltages are recommended:

RANGE	VOLTAGE
10	5.000000
10	10.000000
100	05.00000
100	10.00000
100	50.00000
100	100.0000
1000	005.0000
1000	010.0000
1000	050.0000
1000	100.0000
1000	500.0000
1000	1000.0000
1000	10X0.0000 (or 10100.0000)
1000	1099.999X (or 1099.99910)

SECTION V

LIST OF REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section contains information necessary to describe all normally replaceable parts. Separate assembly lists are used to describe the parts on the final assembly and various assemblies and subassemblies. Each list has a corresponding illustration on which the parts for that list are identified. Parts are called out on both lists and illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are shown on the illustrations by Fluke stock number.

5-3. Each list provides the following information on each part:

a. The REF DESIG. column indicates the reference designation used on the schematic diagram.

b. The DESCRIPTION column describes the part in words, along with any applicable values, tolerances, etc. Indentation is used to show assembly, subassembly, and parts relationship. See abbreviations and symbols on next page.

c. Entries in the FLUKE STOCK NO. column indicate the number by which Fluke stocks the part. This number should be used when ordering parts from the Fluke factory or your Fluke representative.

d. Entries in the MFR. column indicate a typical manufacture of the part by the manufacturer's code number. Appendix A lists the manufacturers and their code numbers.

e. Entries in the MFR. PART NO. column are part numbers assigned by the manufacturer indicated in the Mfg. column.

f. The number in the TOT. QTY. column indicates the total quantity of the part used in the instrument. "REF" indicates that the total quantity of the part has been previously given. The total quantity of each part is listed the first time the part appears. All other listings of the same part refer back to the reference designation of the first appearance of the part for the total quantity.

g. The number in the REC. QTY. column indicates the recommended spares quantity necessary to support approximately one to five instruments for a period of two years. The basis used to select the recommended spares quantity is that a small group of parts will be required to correct a majority of the problems that occur. Since there is a chance that any part may fail, a stock of at least one of every part used in addition to the recommended parts will be needed for complete maintenance during one year of isolated service.

h. The USE CODE column identifies certain parts which have been added, deleted, or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List at the end of this section. These changes are normally made when improved components become available or when the latest circuit improvements are developed by our engineering department. The serial number listed indicates the instruments in which that particular part was used. The symbol "~" is used to indicate an approximate use code. If a different part should be used for replacement, it is listed by Fluke stock number in the description column.

5-4. HOW TO OBTAIN PARTS

5-5. Standard components have been used whenever possible. Thus, most parts can be obtained locally. However, parts may be ordered directly from the manufacturer using the manufacturer's part number or from Fluke using the Fluke stock number. In addition, the most commonly replaced parts that can not be obtained locally may be obtained from your Fluke representative. If a part you have ordered has been replaced by a new or improved part, Fluke will normally send you this part along with an explanation.

5-6. When ordering parts from Fluke always include:

a. Reference designation, description, and Fluke stock number.

b. Instrument model and serial number.

c. Most structural parts are not listed. In this case, give complete description, function, and location of part.

5-7. ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

ac	alternating current	mw	milliwatt
Al	aluminum	na	nanoampere
assy	assembly	pf	picofarad
cap	capacitor	piv	peak inverse voltage
car flm	carbon film	plstc	plastic
cer	ceramic	pp	peak-to-peak
comp	composition	ppm	parts per million
conn	connector	rect	rectifier
cps	cycles per second	res	resistor
db	decibel	rms	root-mean-square
dc	direct current	sb	slow-blow
dpdt	double pole double throw	Si	silicon
dpst	double pole single throw	S/N	serial number
elect	electrolytic	sw	switch
fxd	fixed	spdt	single pole double throw
Ge	germanium	spst	single pole single throw
gmv	guaranteed minimum value	Ta	tantalum
Hz	hertz (cycles per second)	tc	temperature coefficient
K	kilohm	tstr	transistor
kc or Kc	kilocycle	ua	microampere
kHz or KHz	kilohertz (kilocycles per sec)	uf	microfarad
kv	kilovolt	uv	microvolt
kva	kilovolt-ampere	va	volt ampere
ma	milliampere	vac	alternating current volts
Mc or MC	megacycle	var	variable
MHz	megahertz (megacycles per sec)	vdc	direct current volts
meg or M	megohm	w	watt
met flm	metal film	wvdc	direct current working volts
mfg	manufacturer	ww	wirewound
mv	millivolt		

PREFIX SYMBOLS

T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
K or k	kilo	10^{3}
h	hecto	10^{2}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
u	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	anto	10^{-18}

QUANTITY SYMBOLS

a or amp	ampere
f	farad
h	henry
hr	hour
Ω	ohm
sec	second
v or V	volt
w or W	watt

SPECIAL NOTES AND SYMBOLS

~	Approximate use code, or serial number.	Use 0000-000000	Part number indicated should be used if replacement is required.

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Final Assembly (See Figure 5-1)	332A	89536				
	Front End Assembly (See Figure 5-2)	3158-187393 (332A-504)	89536		1		
	Driver and Voltage Trip Assembly (See Figure 5-3)	1702-187211 (332A-402)	89536		1		
	Differential Amplifier Assembly (See Figure 5-4)	1702-187229 (332A-403)	89536		1		
	Chopper Assembly (See Figure 5-5)	1702-187237 (332A-404)	89536		1		
	Auxiliary Supply Assembly (See Figure 5-6)	1702-187245 (332A-405)	89536		1		
	Current Limit Assembly (See Figure 5-7)	1702-187252 (332A-406)	89536		1		
	Front Mother Board Assembly (See Figure 5-8)	1702-187260 (332A-407)	89536		1		
	HV Rectifier Assembly (See Figure 5-9)	1702-187294 (332A-410)	89536		1		
	Series Pass Assembly (See Figure 5-10)	1702-187302 (332A-411)	89536		1		
	Preregulator Assembly (See Figure 5-11)	1702-187310 (332A-412)	89536		1		
	Rear Mother Board Assembly (See Figure 5-12)	1702-187328 (332A-413)	89536		1		
	Extender PCB (not illustrated)	1702-187344 (332A-415)	89536		1		
	Time Delay Assembly (See Figure 5-13)	1702-192260 (332A-420)	89536		1		
C1 to C11	Capacitor, ceramic, 0.05 uf -20/+80%, 500V	1501-105676	56289	33C58	15		
C12	Cap, cer, 0.005 uf ±20%, 3 KV	1501-188003	71590	DD30-502	1		
CR1, CR2	Diode, silicon, 600 PIV, 1A (not illustrated)	4802-112383	14099	SCE6	35	6	
CR3	Diode, silicon, 100 PIV, 1A	4802-116111	14099	SCE1	43	6	B
F1	Fuse, fast acting, 110V, 3A (not illustrated)	5101-109199	03614	Type AGC	1	5	
F2	Fuse, fast acting, 110V, 1/4A (not illustrated)	5101-109314	03614	Type AGC	1	5	
K1	Relay, armature, DPDT, 115 VAC, 10A	4504-196675	89536				B

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R1	Res, WW, 500Ω ±5%, 25W	4706-183533	14193	MC250	1		
R2	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	EB1021	5		
S1A	Switch section, rotary, 2 poles, 3 positions	5107-187872	76854	248214-HC	1		
S1B	Switch section, rotary, 3 poles, 3 positions (not illustrated)	5107-187864	76854	Type HC	1		
S2, S3	Switch, interlock	5104-187708	91929	V3L-45-D827	2		
T1	Transformer, aux.	5600-185845	89536		1		A
	Transformer, aux.	5600-198820	89536		1		C
T2	Transformer, HV	5600-185835	89536		1		I
	Transformer, HV (If replacement is required, use 5600-215228.)	5600-215228	89536		1		J
	Fuseholder (not illustrated)	2102-160846	75915	34-2004	2		
	Line cord, 3 wire	6005-102822	70903	KH4616	1		

1 NOTE: Transformer 5600-198820 may be used in earlier serial number instruments, if the later configuration of circuit board 1702-187310 (Preregulator) is also used.

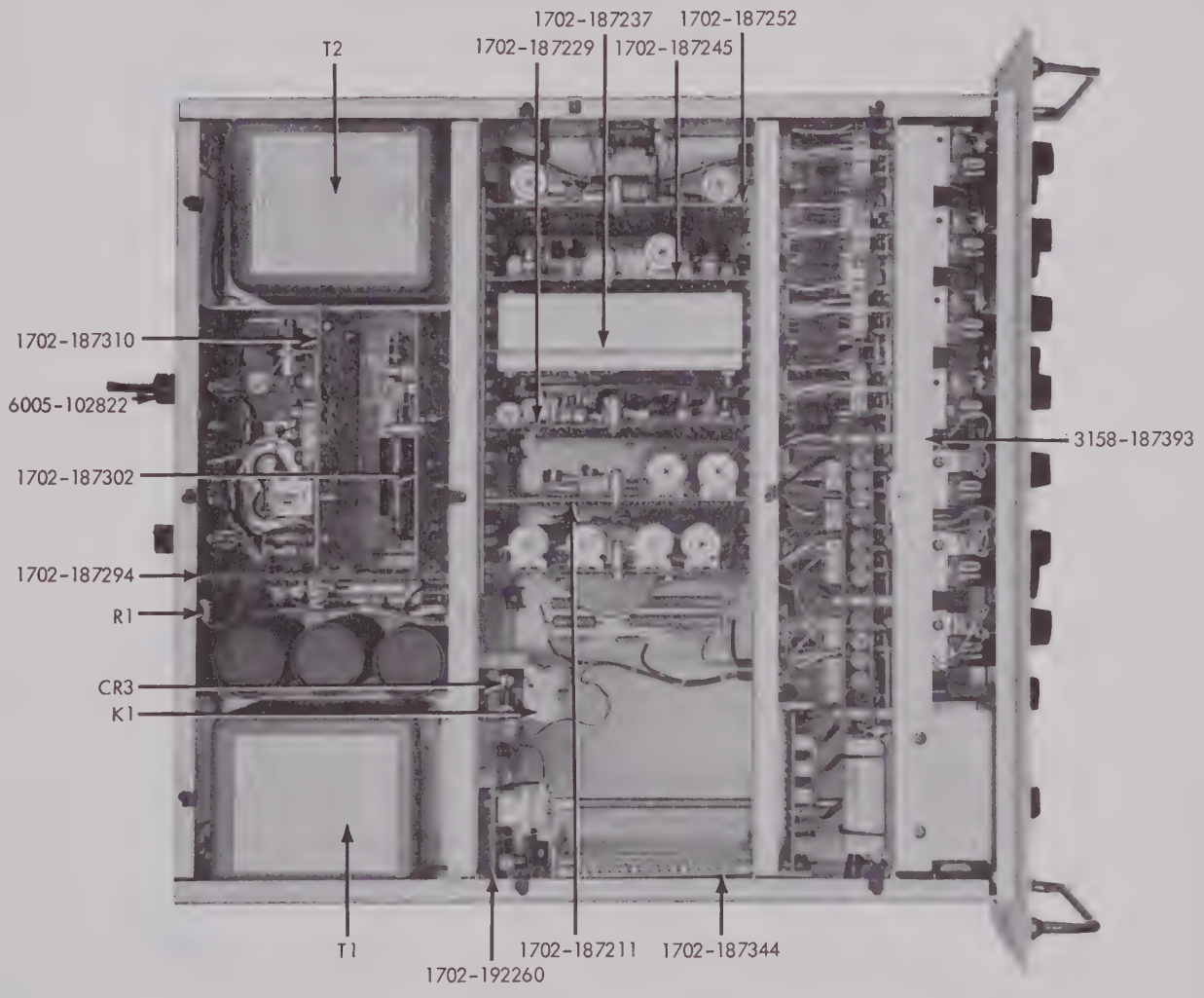


Figure 5-1. FINAL ASSEMBLY (Sheet 1 of 2)

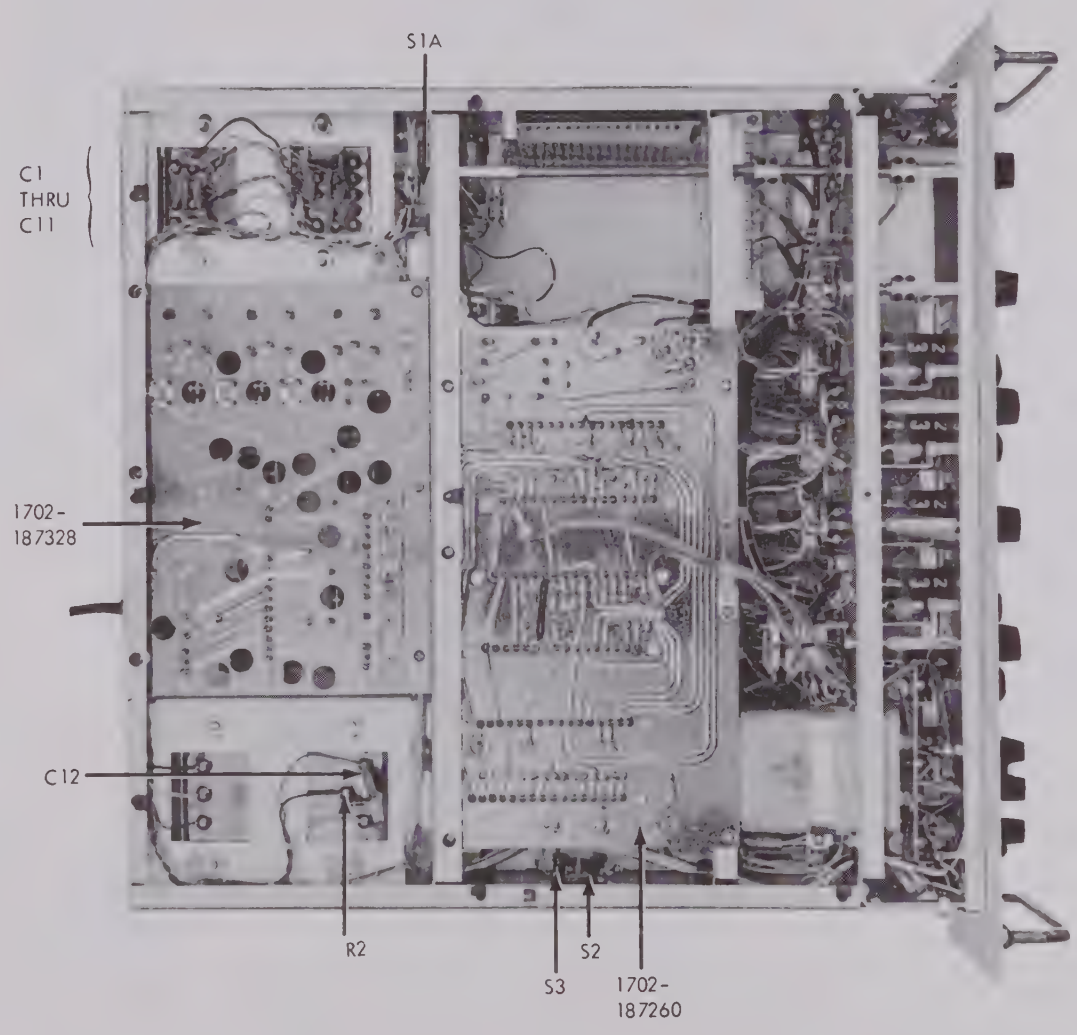


Figure 5-1. FINAL ASSEMBLY (Sheet 2 of 2)

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Front End Assembly	3158-187393 (332A-504)	89536		1		
	Linearity Assembly	1702-187286 (332A-409)	89536		1		
R901	Res, var, met flm, 100Ω ±20%, 3/4W	4701-159889	73138	75PR100	1		
R902 to R906	Res, var, met flm, 200Ω ±20%, 3/4W	4701-186213	73138	75PR200	5		
R907	Res, var, met flm, 10Ω ±30%, 3/4W	4701-186205	73138	75PR10	2		
R908 to R912	Res, var, met flm, 20Ω ±30%, 3/4W	4701-186197	73138	75PR20	5		
	Output PCB Assembly	1702-187351 (332A-416)	89536		1		
C1601, C1602	Cap, plastic, 1 uf ±20%, 200V	1507-106450	84411	X663UW10502	8		
CR1601, CR1602	Diode, silicon, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
	Front Panel Assembly	3158-187385 (332A-419)	89536		1		
	Binding post, black	2811-142984	91407	DF31BC	3		
	Binding post, red	2811-142976	91407	DF31RC	3		
	Handle	2404-101717	07792	C1207	2		
	Capacitor Board Assembly	1702-187476 (332A-428)	89536		1		
C2801, C2802	Cap, plastic, 0.25 uf ±10%, 1200V	1507-183616	84411	JF6	2		
C2803 thru C2806	Cap, plastic, 0.001 uf ±20%, 600V (not illustrated)	1507-105999	56289	15296	4		N
	Subassembly Set, Matched	3158-187500 (332A-431)	89536		1		
	Temp. Regulating Assembly 1	1702-186601 (332A-401)	89536		1		
CR101	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
Q101 to Q103	Transistor, NPN, Si 2	4805-193870	04713	SS-2104	23	6	
Q104	Transistor, NPN, Si	4805-183004	95303	40250	3	1	
R101	Res, var, WW, 10K ±20%, 1-1/4W	4702-112862	71450	Type 110	4		~ A
	Res, var, WW, 10K ±10%, 1-1/4W	4702-162115	71450	Type 110	1		~ C
R102	Res, met flm, 100K ±1%, 1/2W	4705-151316	75042	Type CEC-TO	3		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R103	Res, comp, 33K ±5%, 1/2W	4704-108761	01121	EB3335	3		
R104	Res, comp, 75K ±5%, 1/2W	4704-108928	01121	EB7535	1		
R105	Res, comp, 24K ±5%, 1/2W	4704-108654	01121	EB2435	1		
R106	Res, comp, 10K ±5%, 1/2W	4704-109165	01121	EB1035	5		
R107	Res, WW, factory selected	3	89536				
R108	Res, var, WW, 10K ±20%, 1-1/4W	4702-112862	71450	Same as R101	REF		~ A
	Res, var, WW, 10K ±10%, 1-1/4W	4702-195164	89536		3		~ C
R109	Res, met flm, 6.04K ±1%, 1/2W	4705-162586	75042	Type CEC-TO	5		
R110	Res, var, WW, 10K ±20%, 1-1/4W	4702-112862	71450	Same as R101	REF		~ A
	Res, var, WW, 10K ±10%, 1-1/4W	4702-195164	89536	Same as R108	REF		~ C
R111	Res, met flm, 6.04K ±1%, 1/2W	4705-162586	75042	Same as R109	REF		
R112	Res, var, WW, 10K ±20%, 1-1/4W	4702-112862	71450	Same as R101	REF		~ A
	Res, var, WW, 10K ±10%, 1-1/4W	4702-195164	89536	Same as R108	REF		~ C
R113	Res, met flm, 6.04K ±1%, 1/2W	4705-162586	75042	Same as R109	REF		
	Oven Assembly	5301-187336 (332A-414)	89536		1		
Q1401	Transistor, PNP, silicon	4805-190389	04713	SM4144	12	4	
R1401	Res, WW, 110Ω ±5%	4707-183830	89536		1		
R1402	Thermistor, 500K at 25° C (not illustrated)	4708-185975	15801	GA55P2	1		
	Zener Res Set, Matched	4807-187518 (332A-432)	89536		1		
CR1401, CR1402	Diode, Si, zener, factory selected	4	89536		2		
R1403	Res, met flm, factory selected	3	89536		1		
	Resistor Set	4710-187427 (332A-423)	89536		1		
R2201	Res, WW, 9.9955K ±0.035%, 1/2W	4707-171835	89536		1		
R2202 to R2206	Res, WW, 19.991K ±0.035%, 1/2W	4707-171827	89536		5		
R2301	Res, WW, 1K ±0.01%, 1/2W	4707-171850	89536		1		
R2302 to R2306	Res, WW, 2K ±0.01%, 1/2W	4707-171843	89536		5		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R2401	Res, WW, 100Ω ±0.01%, 1/2W	4707-178970	89536		1		
R2402 to R2406	Res, WW, 200Ω ±0.01%, 1/2W (5)	4707-178988	89536		5		
R2501	Res, WW, 10Ω ±0.03%, 1/4W	4707-131755	89536		1		
R2502 to R2506	Res, WW, 20Ω ±0.03%, 1/2W (5)	4707-155887	89536		5		
R2601	Res, WW, 1Ω ±0.2%, 1/10W	4707-131888	89536		1		
R2602 to R2606	Res, WW, 2Ω ±0.1%, 1/4W	4707-131870	89536		5		
R2701	Res, WW, 0.1Ω ±1%, 1/4W	4707-131904	89536		3		
R2702 to R2706	Res, WW, 0.2Ω ±1%, 1/4W	4707-131896	89536		6		
	Calibration PCB Assembly	1702-187278 (332A-408)	89536				
C801	Cap, plastic, 0.1 uf ±10%, 200V	1507-106013	92741	663UW10492	1		
CR810	Diode, silicon, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
R801	Res, WW, factory selected (6)		89536		1		
R802	Res, var, WW, 500Ω ±5%, 3/4W	4702-187740	12697	76JA-3	1		
R803	Res, WW, factory selected (6)		89536		1		
R804	Res, var, met flm, 500Ω ±20%, 3/4W	4701-159897	73138	75PR500	1		
R805	Res, WW, 601.75K ±0.02%, 1/2W (7)	4707-178285	89536		1		
R806	Res, var, met flm, 50Ω ±20%, 3/4W	4701-186189	73138	75PR50	1		
R807	Res, WW, 60.175K ±0.02%, 1/2W (7)	4707-178277	89536		1		
R808	Res, var, met flm, 10Ω ±20%, 3/4W	4701-186205	73138	Same as R907	REF		
R809	Res, WW, 6.015K ±0.02%, 1/4W (7)	4707-171777	89536		1		
	Resistor PCB Assembly	1702-187492 (332A-430)	89536				
R3001	Res, WW, 99.955K ±0.035%, 1/6W (7)	4707-171819	89536		1		
R3002, R3003	Res, WW, Matched set 99.955K ±0.035%, 1/6W (8)	4710-187419	89536		5		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R3004, R3005	Res, WW, Matched set 99.955K ±0.035%, 1/6W	4710-187419 △8	89536	Same as R3002, R3003.	REF		
R3006, R3007	Res, WW, Matched set 99.955K ±0.035%, 1/6W	4710-187419 △8	89536	Same as R3002, R3003.	REF		
R3008, R3009	Res, WW, Matched set 99.955K ±0.035%, 1/6W	4710-187419 △8	89536	Same as R3002, R3003.	REF		
R3010, R3011	Res, WW, Matched set 99.955K ±0.035%, 1/6W	4710-187419 △8	89536	Same as R3002, R3003.	REF		
S2101	Readout Module Assembly (Includes switch, drum and mounting bracket)	3158-187401	89536		7 1		E F
S2201	Readout Module Assembly Readout Module Assembly	3158-187401 3158-200816	89536 89536	Same as S2101	REF 6		 F
S2301	Readout Module Assembly Readout Module Assembly	3158-187401 3158-200816	89536 89536	Same as S2101 Same as S2201	REF REF		
S2401	Readout Module Assembly Readout Module Assembly	3158-187401 3158-200816	89536 89536	Same as S2101 Same as S2201	REF REF		
S2501	Readout Module Assembly Readout Module Assembly	3158-187401 3158-200816	89536 89536	Same as S2101 Same as S2201	REF REF		
S2601	Readout Module Assembly Readout Module Assembly	3158-187401 3158-200816	89536 89536	Same as S2101 Same as S2201	REF REF		
S2701	Readout Module Assembly Readout Module Assembly	3158-187401 3158-200816	89536 89536	Same as S2101 Same as S2201	REF REF		
C1603	Cap, oil, 4 uf ±10%, 1200V	1505-183541	90205	CMLE405K12	1		
DS1, DS2, DS3	Lamp, incandes, 28V, 35 ma Lamp, incandes, 28V, 80 ma	3901-186346 3901-175265	71744 89730	1819 757	3 3	3 3	A C
DS4, DS5	Lamp, incandes, 28V, 35 ma	3901-186346	71744	1819	2		
M1	Meter, 1 ma ±2%, 77Ω	2901-184325	38315	MS24T	1		
R3	Res, var, WW, 5K ±20%, 2W	4702-185470	11237	Type 252	1		
R4	Res, var, WW, 300Ω ±20%, 2W	4707-185462	11237	Type 252	1		
R5	Res, comp, 47K ±10%, 2W (not illustrated)	4704-110015	01121	HB4721	1		
S2	Switch, rotary, 11 pole, 3 position	5105-187138	89536		2		
S3	Switch, rotary, 2 pole, 2 position	5105-187146	89536		1		
	Knob, 5/8" dia.	2405-158949	89536		7		~A
	Knob, 13/16" dia.	2405-170068	89536		7		~C

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Knob, with bar, 13/16" dia.	2405-188524	89536		3		
	Knob, 13/16" dia.	2405-188540	89536		2		
	Grommet, 3/8" dia, Polyethelene (not illustrated)	2807-171876	89536		4		

1 Part number 1702-186601 does not include R107, or the oven assembly 5301-187336. If replacement is required, we recommend useage of Reference Assembly Kit 2906-199745, which includes part numbers 1702-186601 and 5301-187336, and also R107, R801, and R803.

2 Earlier instruments may have used different transistors in some locations. Part Number 4805-193870 can be used for replacement when listed.

3 Factory selected. If replacement is required, include information on zener oven decal, and instrument serial number.

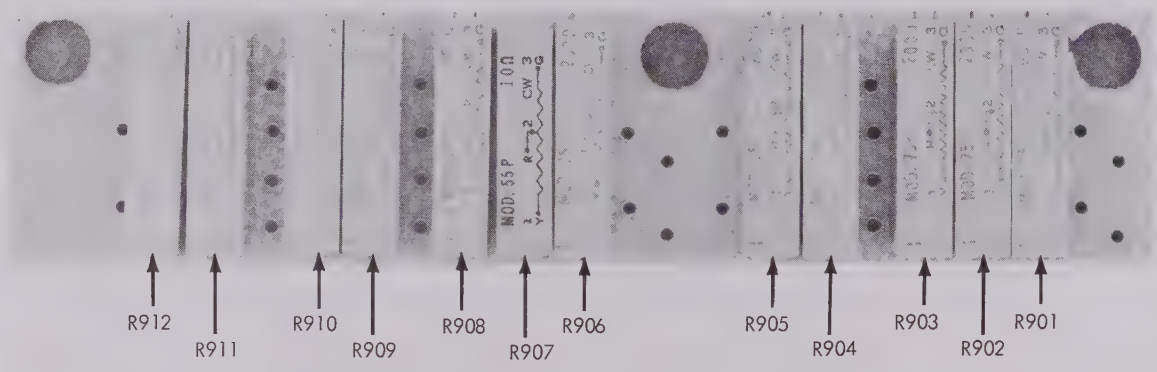
4 Aged and factory selected. If replacement is required, order zener resistor set 4807-187518.

5 R2201 through R2506 are factory matched for resistance accuracy and temperature coefficient. When ordering include all information stamped on old resistor (if unavailable include information on an adjacent resistor) and instrument serial number.

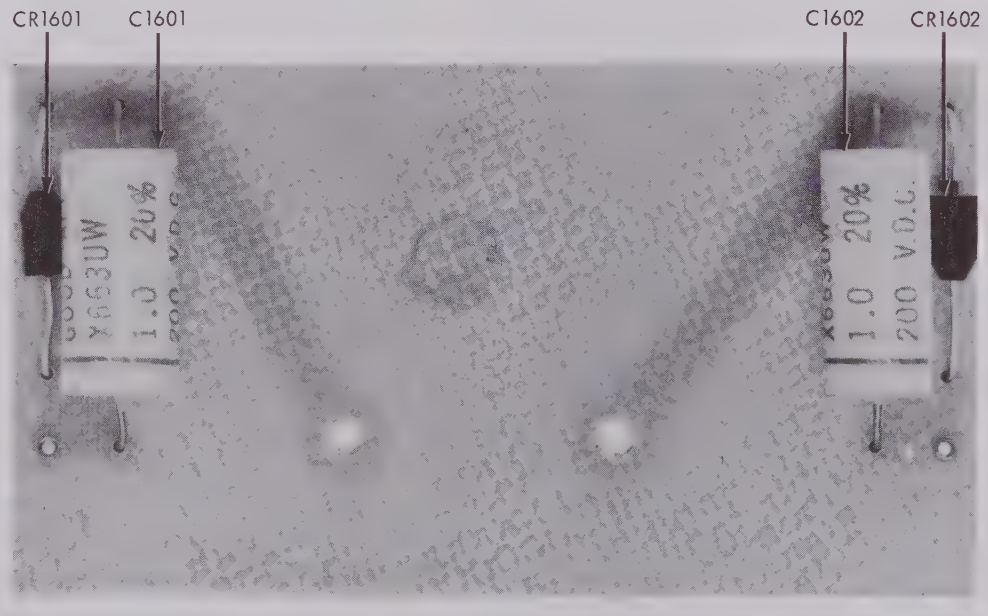
6 R801 and R803 are factory matched to CR1402. If replacement is required, include all information on zener oven decal, and instrument serial number.

7 R805, R807, and R809 are factory matched to each other and to R3001. When ordering, include all information stamped on old resistor, and instrument serial number.

8 Part No. 4710-187419 identifies pair matched for temperature coefficient. If one resistor becomes defective, replacement of the pair is necessary.

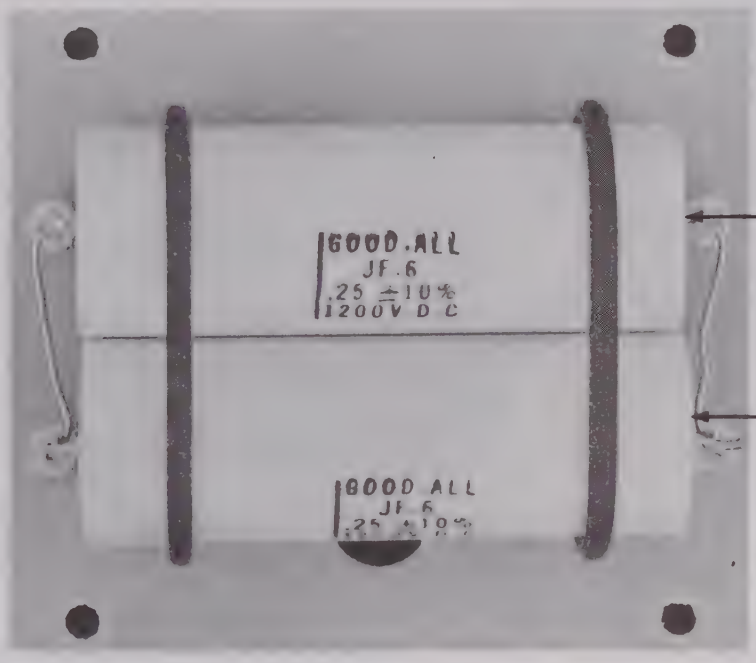


Linearity Assembly

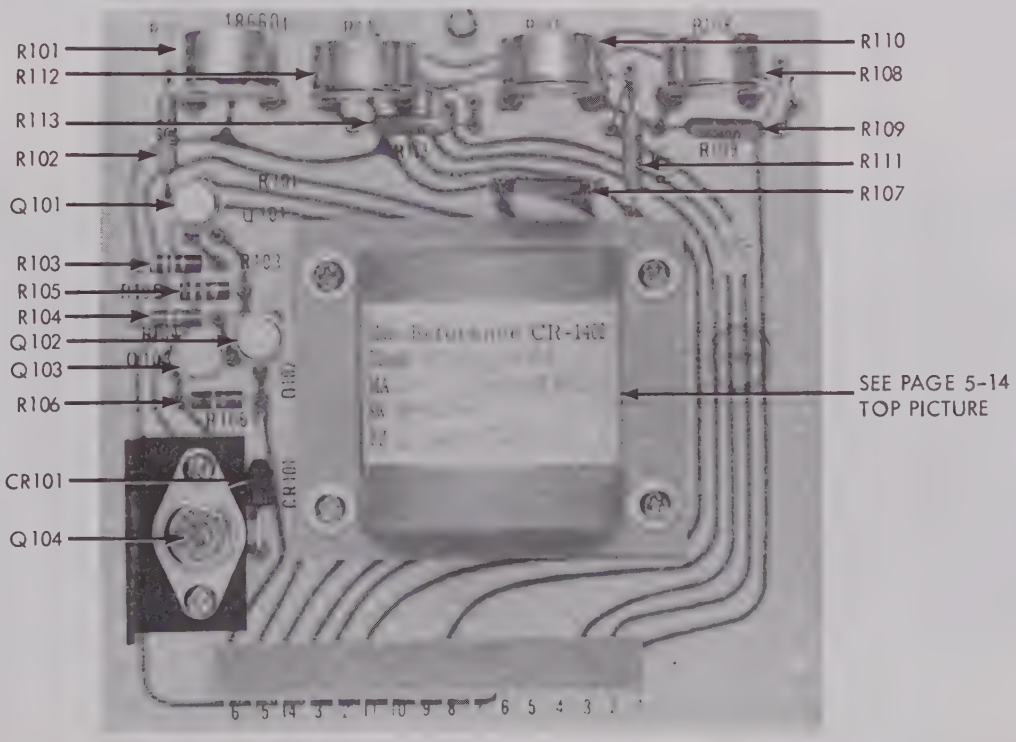


Output PCB Assembly

Figure 5-2. FRONT END ASSEMBLY (Sheet 1 of 4)



Capacitor Board Assembly



Temperature Regulating Assembly

Figure 5-2. FRONT END ASSEMBLY (Sheet 2 of 4)

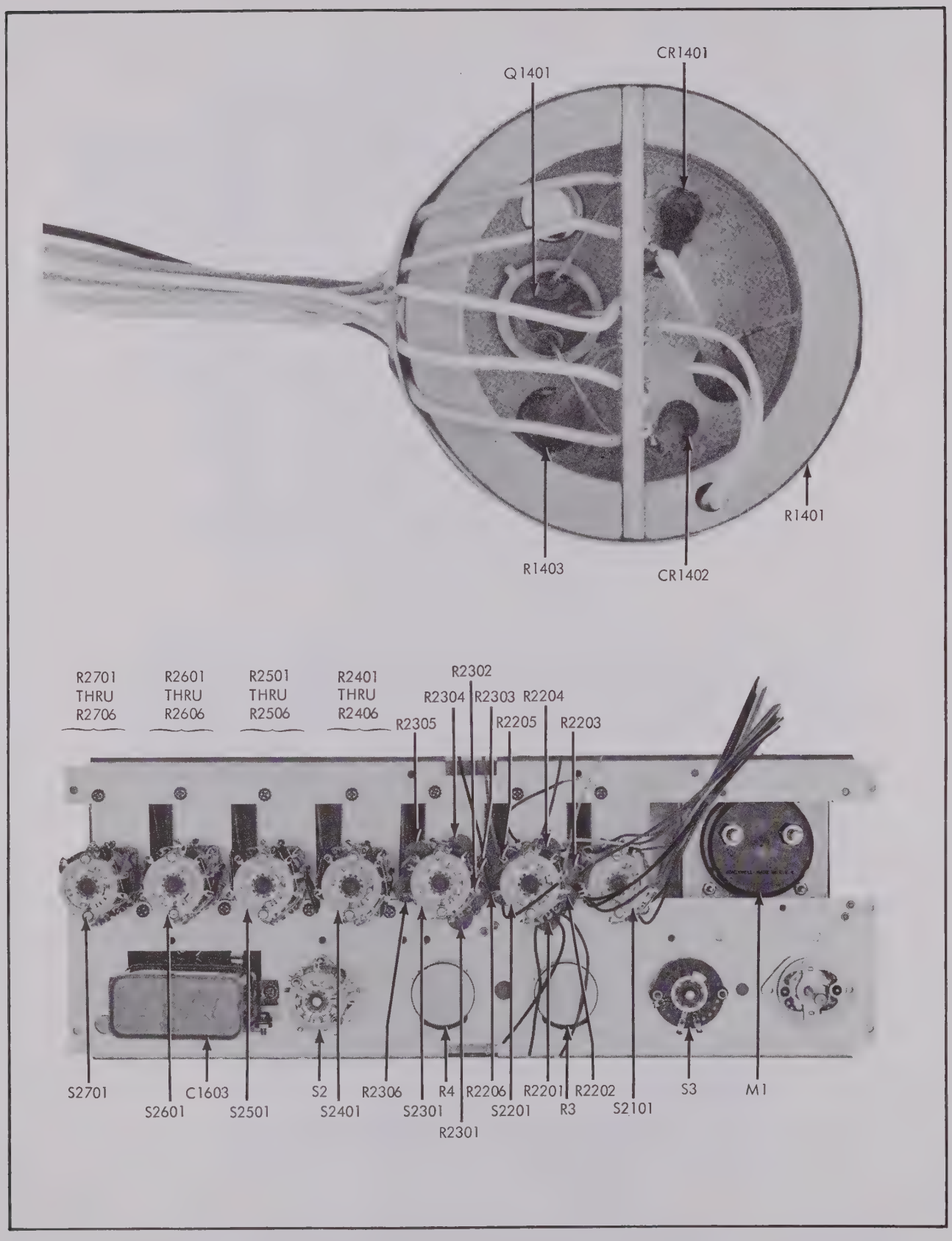


Figure 5-2. FRONT END ASSEMBLY (Sheet 3 of 4)

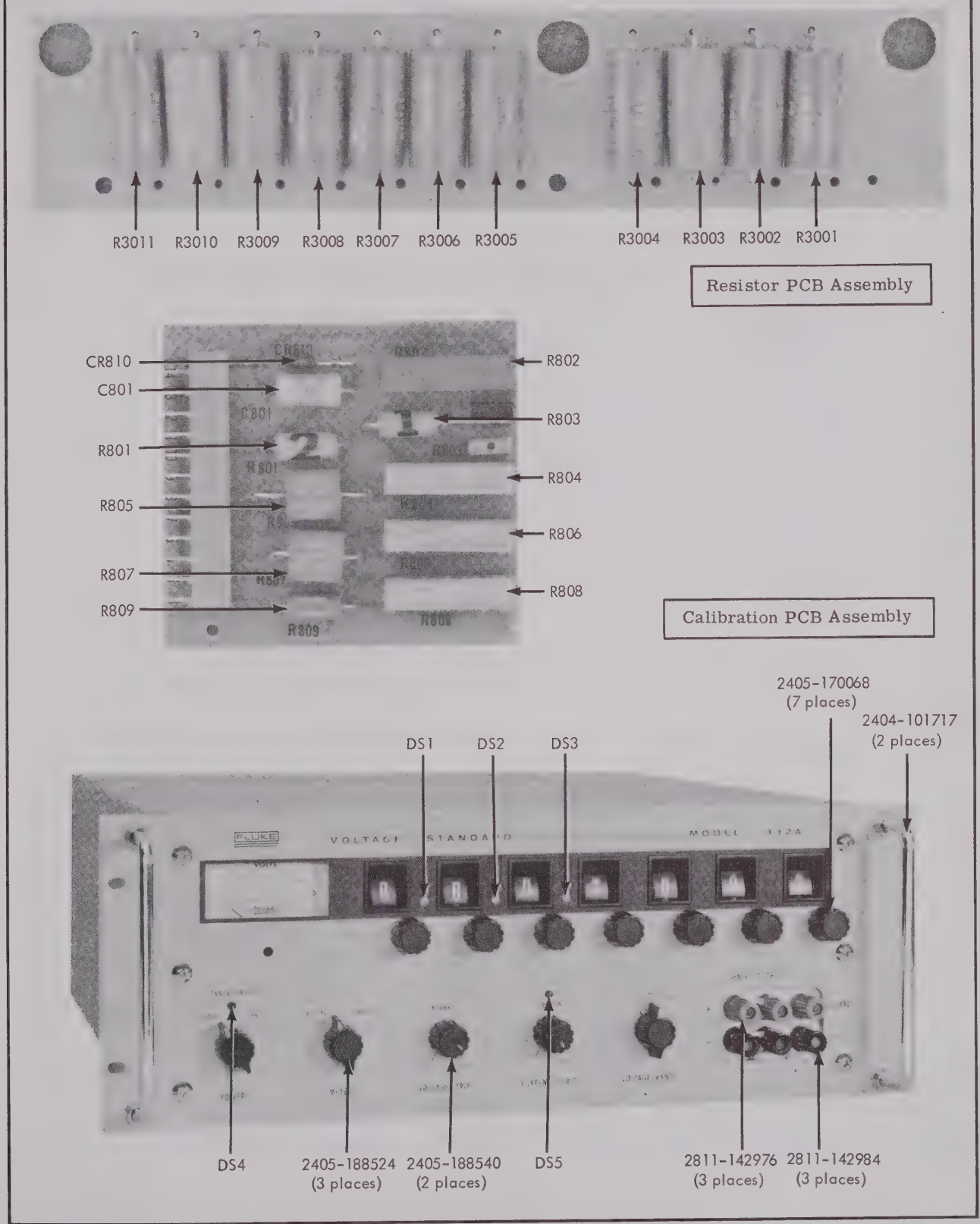


Figure 5-2. FRONT END ASSEMBLY (Sheet 4 of 4)

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Driver and Voltage Trip Assembly	1702-187211 (332A-402)	89536		1		
C201	Cap, plstc, 0.22 uf ±10%, 80V	1507-159392	56289	192P2249R8	1		
C202, C203	Cap, plstc, 1 uf ±20%, 200V	1507-106450	84411	Same as C1601	REF		
C204	Cap, Al elect, 2 uf -10/+75%, 50V	1502-105197	56289	30D205G050BA4	2	1	
C205	Cap, plstc, 0.022 uf ±20%, 100V	1507-106039	84411	663UW22301	1		
C206	Cap, Al elect, 15 uf -10/+75%, 6V	1502-105700	56289	30D156G006BA4	1	1	
C207	Cap, plstc, 0.1 uf ±20%, 200V	1507-106435	56289	192P10402	4		
C208	Cap, Al elect, 1250 uf -10/+50%, 4V	1502-166330	73445	C437ARB1250	1	1	
CR201, CR202	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
CR203, CR204	Diode, Si, 6 PIV, 0.15A, -2 mv/° C	4802-113308	07910	CD13161	2	1	
CR205 to CR208	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
CR209	Diode, Ge, 125 PIV, 0.075A	4802-150342	03615	1N277	1	1	
Q201	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		
Q202	Transistor, PNP, Si	4805-190389	04713	Same as Q401	REF		
Q203	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		
Q204, Q205	Transistor, PNP, Si	4805-190389	04713	Same as Q1401	REF		
Q206, Q207	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		
R201	Res, met flm, 10.2Ω ±1%, 1/2W	4705-182568	75042	Type CEC-TO	1		
R202	Res, comp, 27K ±10%, 1/2W	4704-108878	01121	EB2731	1		
R203	Res, comp, 15Ω ±10%, 1/2W	4704-165720	01121	EB1501	1		
R204	Res, comp, 10K ±10%, 1/2W	4704-108118	01121	EB1031	2		
R205	Res, comp, 16K ±5%, 1/2W	4704-159632	01121	EB1635	1		
R206	Res, comp, 3.9K ±5%, 1/2W	4704-180596	01121	EB3925	1		
R207	Res, comp, 20K ±5%, 1/2W	4704-109041	01121	EB2035	1		
R208	Res, met flm, 301Ω ±1%, 1/2W	4705-167494	75042	Type CEC-TO	1		
R209	Res, met flm, 100Ω ±1%, 1/2W	4705-167486	75042	Type CEC-TO	1		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R210	Res, var, WW, 200Ω ±20%, 1-1/4W	4702-192153	71450	Type 110	1		
R211	Res, met flm, 150Ω ±1%, 1/2W	4705-182550	75042	Type CEC-TO	1		
R212	Res, comp, 36K ±5%, 1/2W	4704-185991	01121	EB3625	1		
R213	Res, var, WW, 3K ±20%, 1-1/4W	4702-149781	71450	Type 110	1		
R214	Res, met flm, 221K ±1%, 1/2W	4705-182527	75042	Type CEC-TO	1		
R215	Res, comp, 100K ±10%, 1/2W	4704-108126	01121	EB1041	9		
R216	Res, comp, 47K ±10%, 1/2W	4704-108480	01121	EB4731	2		
R217	Res, comp, 620Ω ±5%, 1/2W	4704-108704	01121	EB6215	1		
R218	Res, comp, 47K ±10%, 1/2W	4704-108480	01121	Same as R216	REF		
R219	Res, comp, 300Ω ±5%, 1W	4704-185876	01121	GB3015	1		
R220	Res, comp, 2K ±5%, 1/2W	4704-169854	01121	EB2025	4		
R221	Res, comp, 4.7K ±10%, 1/2W	4704-108381	01121	EB4721	2		
R222	Res, met flm, 1K ±1%, 1/2W	4705-151324	75042	Type CEC-TO	1		

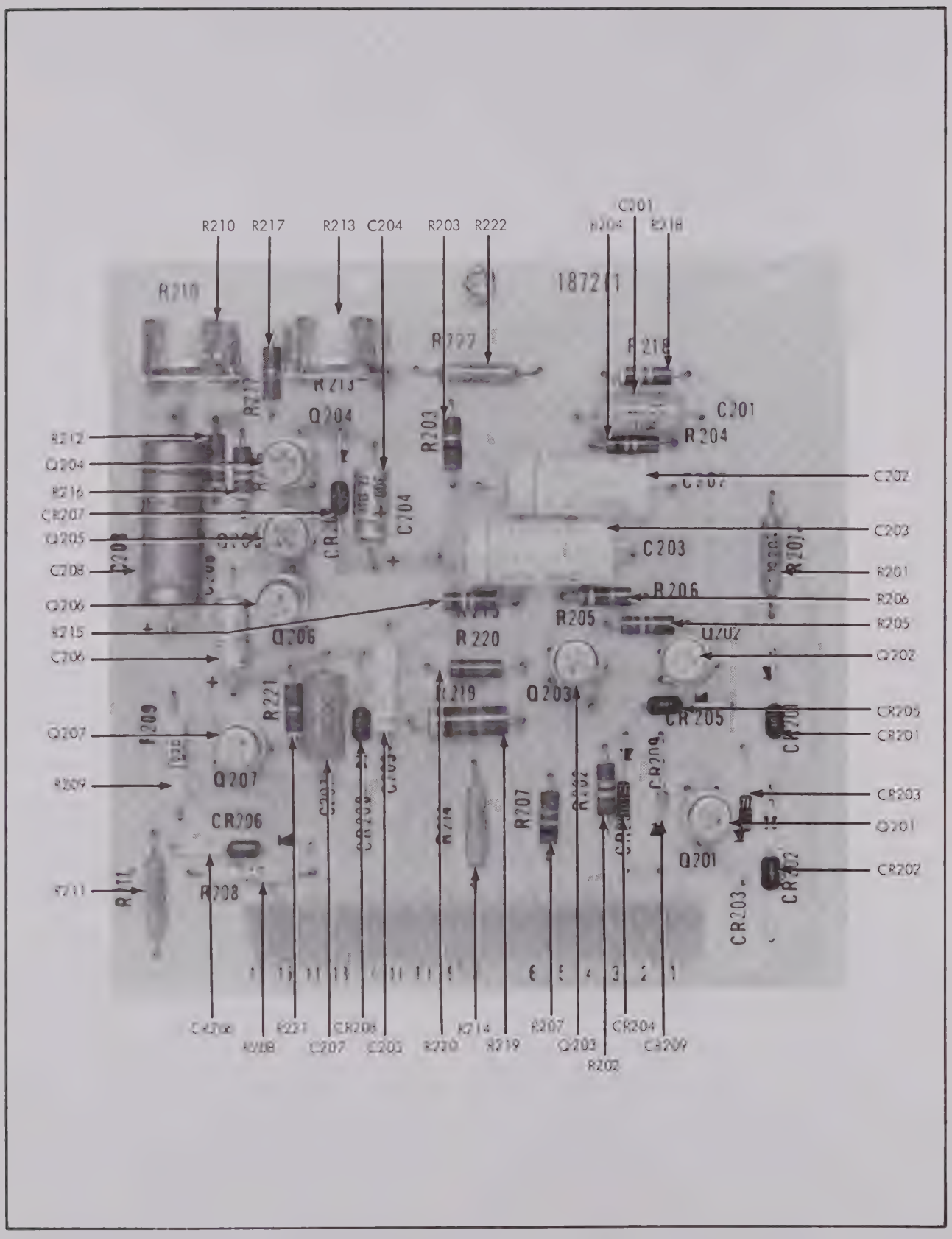


Figure 5-3. DRIVER AND TRIP ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Differential Amplifier Assembly	1702-187229 (332A-403)	89536		1		
C301	Cap, plstc, 0.047 uf ±10%, 50V	1507-150300	56289	194P4739R5	1		
C302	Cap, Ta, elect, 68 uf ±10%, 15V	1408-182824	05397	K68C15K	1		
C303	Cap, cer, 0.0012 uf ±10%, 500V	1501-106732	71590	CF-122	2		
C304	Cap, mica, 510 pf ±5%, 500V	1504-148411	88419	CD19F511J	1		O
C305	Cap, elect, 250 uf -10/+50%, 40V	1502-178616	73445	C437ARG250	1		O
C307	Cap, plstc, 1 uf ±20%, 200V	1507-106450	84411	Same as C1601	REF		G
CR301 to CR307	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
CR308	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		O
Q301	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		
Q302	Transistor, field-effect, N-channel, Si	4805-166223	15818	U-1249	2	1	
Q303	Transistor, PNP, Si	4805-190389	04713	Same as Q1401	REF		
Q304	Transistor, NPN, Si	4805-168716	07910	CDQ23153	2	1	
Q305	Transistor, PNP, Si	4805-190389	04713	Same as Q1401	REF		
Q306	Transistor, NPN, Si	4805-168716	07910	Same as Q304	REF		
Q307	Transistor, PNP, Si	4805-190389	04713	Same as Q1401	REF		
Q308	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		
Q309 to Q311	Transistor, PNP, Si	4805-183558	04713	2N3250	3	1	
R301	Res, comp, 47K ±5%, 1/2W	4704-108738	01121	EB4735	2		
R302	Res, comp, 10K ±5%, 1/2W	4704-109165	01121	Same as R106	REF		
R303, R304	Res, comp, 1K ±5%, 1/2W	4704-108597	01121	EB1025	4		
R305	Res, comp, 100Ω ±10%, 1/2W	4704-108100	01121	EB1011	1		
R306	Res, WW, 10K ±0.02%, 1/3W	4707-112177	15909	Type 1250	1		
R307	Res, comp, 100Ω ±10%, 1W	4704-109363	01121	GB1011	1		
R308	Res, comp, 22K ±10%, 1/2W	4704-108209	01121	EB2231	1		
R309	Res, comp, 22M ±10%, 1/2W	4704-108233	01121	EB2261	1		
R310	Res, comp, 1.2K ±10%, 1/2W	4704-108803	01121	EB1221	1		
R311	Res, comp, 6.2K ±5%, 1/2W	4704-108621	01121	EB6225	2		
R312	Res, met flm, 100K ±1%, 1/2W	4705-151316	75042	Same as R102	REF		
R313	Res, met flm, 221K ±1%, 1/2W	4705-182527	75042	Type CEC-TO	2		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R314	Res, met flm, 40.2K ±1%, 1/2W	4705-161059	75042	Type CEC-TO	2		
R315, R316	Res, met flm, 75Ω ±1%, 1/2W	4705-150870	75042	Type CEC-TO	2		
R317	Res, met flm, 221K ±1%, 1/2W	4705-182527	75042	Same as R313	REF		
R318	Res, met flm, 40.2K ±1%, 1/2W	4705-161059	75042	Same as R314	REF		
R319	Res, met flm, 6.04K ±1%, 1/2W	4705-162586	75042	Same as R109	REF		
R320	Res, met flm, 42.2K ±1%, 1/2W	4705-182501	75042	Type CEC-TO	1		
R321	Res, met flm, 9.09K ±1%, 1/2W	4705-151258	75042	Type CEC-TO	1		
R324, R325	Res, met flm, 1.58K ±1%, 1/2W	4705-182543	75042	Type CEC-TO	2		
R326	Res, met flm, 9.76K ±1%, 1/2W	4705-182485	75042	Type CEC-TO	1		
R327	Res, met flm, 15K ±1%, 1/2W	4705-151498	75042	Type CEC-TO	1		
R328	Res, comp, 10K ±5%, 1/2W	4704-109165	01121	Same as R106	REF		
R329	Res, comp, 1K ±5%, 1/2W	4704-108597	01121	Same as R303	REF		

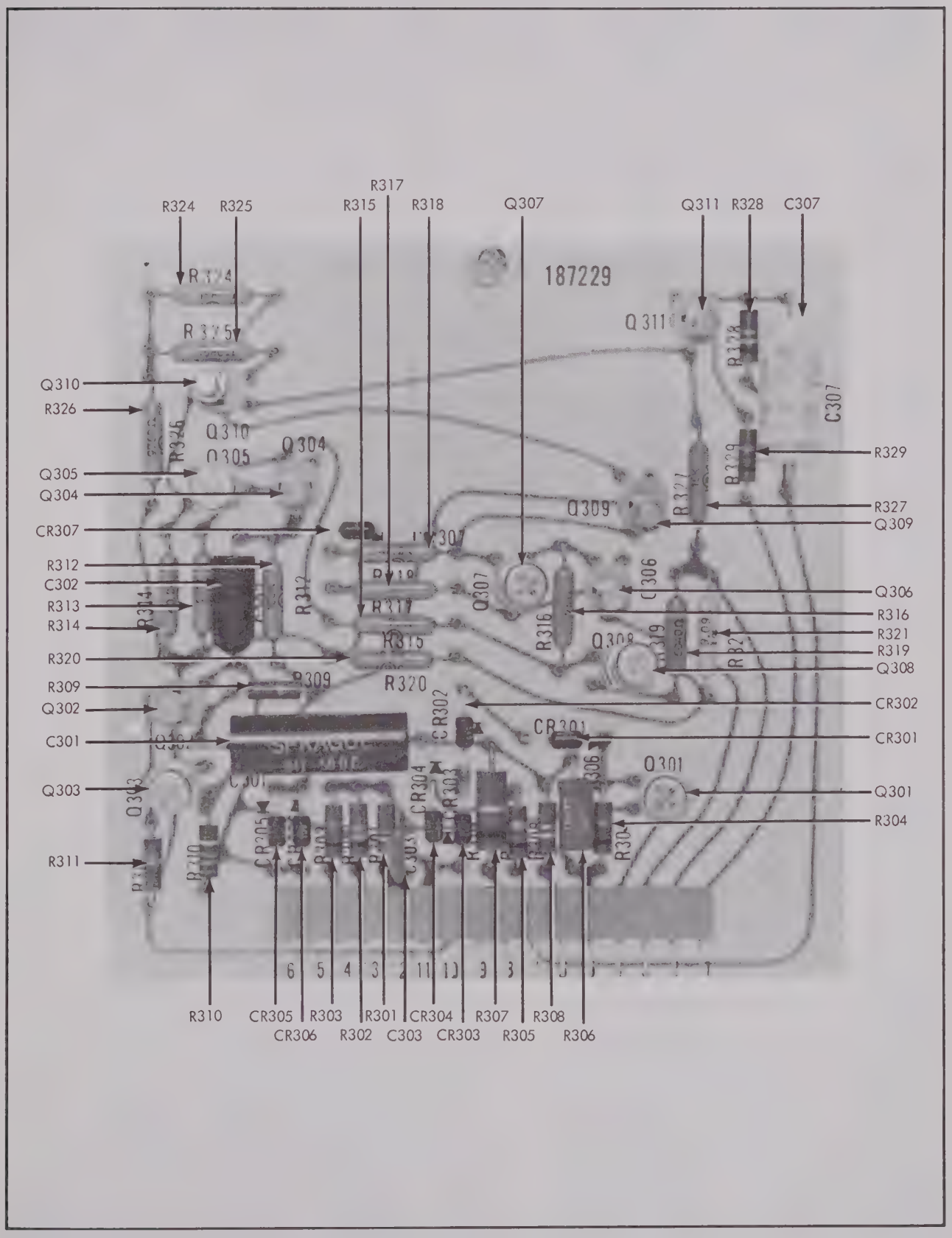


Figure 5-4. DIFFERENTIAL AMPLIFIER ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Chopper Assembly	1702-187237 (332A-404)	89536		1		
C401, C402	Cap, plstc, 0.033 uf ±10%, 200V	1507-106062	56289	192P47392	2		
C403	Cap, plstc, 0.1 uf ±20%, 200V	1507-106435	56289	Same as C207	REF		
C404	Cap, Al elect, 100 uf -10/+75%, 25V	1502-106518	56289	30D107G025DH4	2	1	
C405	Cap, Al elect, 20 uf -10/+75%, 50V	1502-106229	56289	30D206G050DC4	8	2	
C406	Cap, cer, 0.0012 uf ±10%, 500V	1501-106732	71590	Same as C303	REF		
C407	Cap, Al elect, 100 uf -10/+75%, 25V	1502-106518	56289	Same as C404	REF		
C408, C409, C410	Cap, Al elect, 20 uf -10/+75%, 50V	1502-106229	56289	Same as C405	REF		
C411	Cap, Al elect, 250 uf -10/+50%, 64V	1502-185850	73445	C437ARH250	4	1	
C412	Cap, plstc, 0.0047 uf ±20%, 200V	1507-106054	56289	192P47202	1		
CR401, CR402	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
CR403, CR404	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		D
CR405	Diode, Ge, 125 PIV, 0.075A	4802-150342	93332	1N277	3	1	D
G401	Chopper, mechanical, DPDT, 10V, 0.001A	5901-104349	98743	C2341	1		
Q401	Transistor, field-effect, N-channel, Si	4805-166223	15818	Same as Q302	REF		
Q402	Transistor, PNP, Si	4805-190389	04713	Same as Q1401	REF		
Q403, Q404, Q405	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		
R401	Res, comp, 22K ±10%, 1/2W	4704-108209	01121	EB2231	1		
R402	Res, comp, 2.2K ±10%, 1/2W (not illustrated)	4704-108605	01121	EB2221	2		
R403	Res, comp, 10Ω ±10%, 1/2W	4704-108092	01121	EB1001	1		
R404, R405	Res, met flm, 604K ±1%, 1/2W	4705-182493	75042	Type CEC-TO	2		
R406	Res, comp, 3.3M ±10%, 1/2W	4704-108282	01121	EB3351	1		
R407	Res, comp, 200Ω ±5%, 1/2W	4704-169839	01121	EB2015	1		
R408	Res, comp, 16K ±5%, 1/2W	4704-159632	01121	EB1635	1		
R409	Res, comp, 6.2K ±5%, 1/2W	4704-108621	01121	EB6225	1		
R410, R411	Res, comp, 15K ±10%, 1/2W	4704-108530	01121	EB1531	5		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R412	Res, comp, 47K ±5%, 1/2W	4704-108738	01121	Same as R301	REF		
R413	Res, met flm, 150Ω ±1%, 1/2W	4705-182550	75042	Type CEC-TO	1		
R414	Res, comp, 120K ±10%, 1/2W	4704-108779	01121	EB1241	1		
R415	Res, met flm, 23.7K ±1%, 1/2W	4705-169383	75042	Type CEC-TO	1		
R416	Res, comp, 15K ±10%, 1/2W	4704-108530	01121	Same as R410	REF		
R417	Res, comp, 10K ±5%, 1/2W	4704-109165	01121	Same as R106	3		
R418	Res, comp, 30K ±5%, 1/2W	4704-186015	01121	EB3035	REF		
R419	Res, comp, 15K ±10%, 1/2W	4704-108530	01121	Same as R410	REF		
R420, R421	Res, comp, 3K ±5%, 1/2W	4704-109090	01121	EB3025	2		
R422, R423	Res, comp, 10K ±5%, 1/2W	4704-109165	01121	Same as R106	REF		
R424	Res, comp, 15K ±10%, 1/2W	4704-108530	01121	Same as R410	REF		
R425	Res, comp, 27K ±5%, 1/2W	4704-186023	01121	EB2735	1		

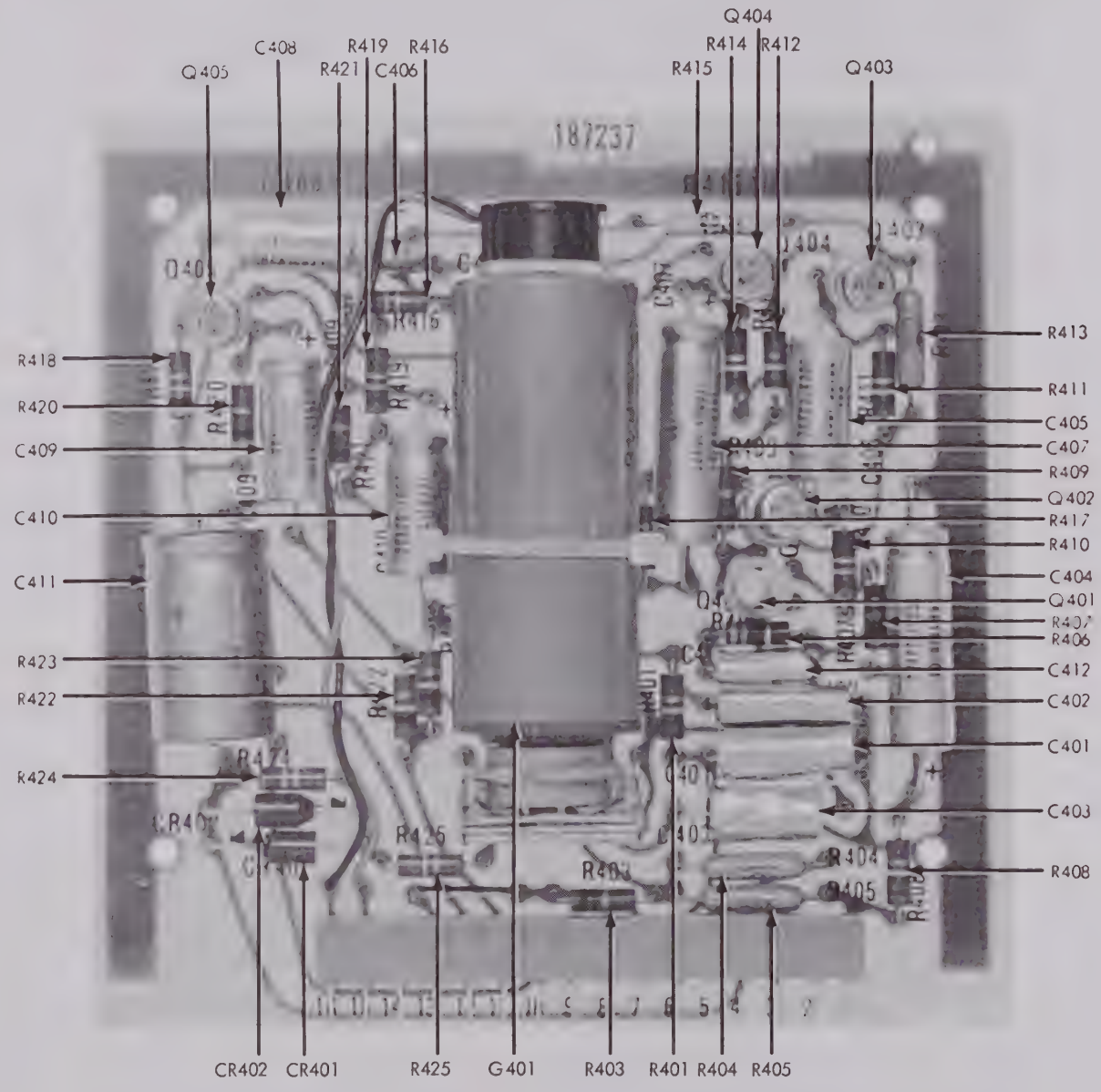


Figure 5-5. CHOPPER ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Auxiliary Supply Assembly	1702-187245 (332A-405)			1		
C501	Cap, Al elect, 250 uf -10/+50%, 64V	1502-185850	73445	Same as C411	REF		
C502	Cap, Al elect, 50 uf -10/+75%, 50V	1502-105122	56289	30D506G050DH4	2	1	
C503	Cap, cer, 220 pf ±10%, 500V	1501-105528	72982	315-024X5UD-221K	1		
C504	Cap, plstc, 2 uf ±20%, 100V	1507-106963	84411	Type X663FR	2		
C505	Cap, plstc, 0.1 uf ±20%, 200V	1507-106435	56289	Same as C207	REF		
C506	Cap, Al elect, 20 uf -10/+75%, 50V	1502-106229	56289	Same as C405	REF		
C507	Cap, Al elect, 50 uf -10/+75%, 50V	1502-105122	56289	Same as C502	REF		
C508	Cap, plstc., 0.0012 uf ±10%, 200V	1507-106088	56289	192P12292	1		
C509	Cap, plstc., 2 uf ±20%, 100V	1507-106963	84411	Same as C504	REF		
C510	Cap, Al elect, 20 uf -10/+75%, 50V	1502-106229	56289	Same as C405	REF		
CR501 to 504	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
CR505	Diode, zener, 3.9V, 0.400 watts	4803-113316	07910	1N748	2	1	
CR506	Diode, zener, 6.3V, 0.0075A	4803-172148	03877	1N3496	1	1	
CR507 to 510	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
Q501	Transistor, PNP, Si	4805-190389	04713	Same as Q1401	REF		
Q502	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		
Q503	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		K
	Transistor, NPN, Si	4805-150359	95303	2N3053	2		L
Q504 Q505	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		
Q506	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		K
	Transistor, NPN, Si	4805-150359	95303	Same as Q503	REF		L
Q507 Q508	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		
R501	Res, comp, 82Ω ±10%, 2W	4704-110239	01121	HB8201	2		
R502	Res, comp, 15K ±10%, 1/2W	4704-108530	01121	Same as R410	REF		
R503	Res, comp, 3K ±5%, 1/2W	4704-109090	01121	EB3025	1		
R504	Res, comp, 33K ±5%, 1/2W	4704-108761	01121	EB3335	1		
R505	Res, var, WW, 1K ±20%, 1-1/4W	4702-113266	71450	Type 110	1		
R506	Res, met flm, 7.15K ±1%, 1/2W	4705-186072	75042	Type CEC-TO	1		
R507	Res, met flm, 2.55K ±1%, 1/2W	4705-176362	75042	Type CEC-TO	1		
R508	Res, comp, 6.2K ±5%, 1/2W	4704-108621	01121	Same as R311	1		
R509	Res, met flm, 2.37K ±1%, 1/2W	4705-182519	75042	Type CEC-TO	1		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R510	Res, comp, 82Ω ±10%, 2W	4704-110239	01121	Same as R501	REF		
R511	Res, comp, 8.2K ±10%, 1/2W	4704-147777	01121	EB8221	1		
R512	Res, comp, 4.7K ±10%, 1/2W	4704-108381	01121	EB4721	1		
R513	Res, comp, 3.3K ±10%, 1/2W	4704-108373	01121	EB3321	3		
R514	Res, met flm, 8.45K ±1%, 1/2W	4705-159475	75042	Type CEC-TO	1		
R515	Res, met flm, 4.99K ±1%, 1/2W	4705-148890	75042	Type CEC-TO	1		
R516	Res, comp, 12K ±10%, 1/2W	4704-108977	01121	EB1231	1		

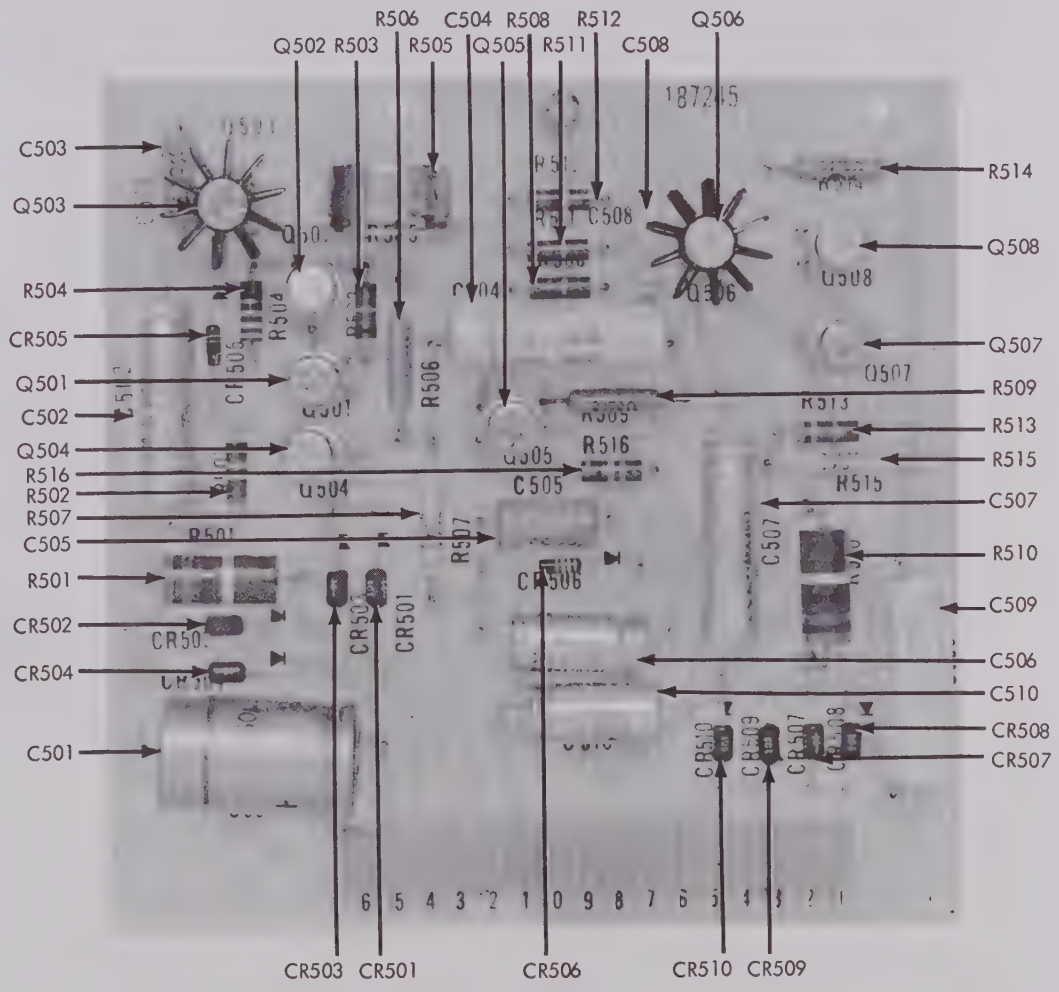


Figure 5-6. AUXILIARY SUPPLY ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Current Limit Assembly	1702-187252 (332A-406)	89536				
C601	Cap, Al elect, 250 uf -10/+50%, 64V	1502-185850	73445	Same as C411	REF		
C602, C603, C604	Cap, Al elect, 20 uf -10/+75%, 50V	1502-106229	56289	Same as C405	REF		
C605	Cap, Al elect, 250 uf -10/+50%, 64V	1502-185850	73445	Same as C411	REF		
C606	Cap, Al elect, 20 uf -10/+75%, 50V	1502-106229	56289	Same as C405	REF		
C607	Cap, Ta elect, 10 uf ±10%, 20V	1508-160259	05397	K10C20K	1		
C608	Cap, Al elect, 2 uf -10/+75%, 50V	1502-105197	56289	Same as C204	REF		
CR601 to CR604	Diode, Si, 600 PIV, 1A	4802-112383	14099	Same as CR1	REF		
CR605	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
CR606, CR607	Diode, zener, 36V, 0.400W	4803-186163	07910	1N974B	3	1	
CR608	Diode, Si, 6 PIV, 0.150A, -2 mv/°C	4802-113308	07910	Same as CR203	REF		
CR609	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
CR610	Diode, zener, 12V, 0.400W	4803-159780	07910	1N759	1	1	
CR611	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
CR612	Diode, zener, 3.9V, 0.400W	4803-113316	07910	Same as CR505	REF		
Q601	Transistor, NPN, Si	4805-183004	95303	Same as Q104	REF		
Q602	Transistor, PNP, Ge	4805-152868	95303	2N2869	1	1	
Q603	Transistor, PNP, Si	4805-190389	04713	Same as Q1401	REF		
Q604	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		
Q605	Transistor, PNP, Si	4805-190389	04713	Same as Q1401	REF		
Q606	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		
Q607	Transistor, PNP, Si	4805-190389	04713	Same as Q1401	REF		
R601	Res, comp, 100Ω ±10%, 2W	4704-109934	01121	HB1011	1		
R602, R603	Res, comp, 3.3K ±10%, 1/2W	4704-108373	01121	Same as R510	REF		
R604	Res, comp, 56Ω ±10%, 2W	4704-110221	01121	HB5601	1		
R605	Res, comp, 680Ω ±10%, 2W	4704-190231	01121	HB6811	1		A
	Res, met flm, 250Ω ±5%, 2W	4705-197434	07115	Type C42S	1		C

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R606	Res, comp, 470Ω ±5%, 1W	4704-109710	01121	GB4711	1		
R607	Res, comp, 33K ±5%, 1/2W	4704-108761	01121	Same as R103	REF		
R608	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	Same as R2	REF		
R609	Res, comp, 33K ±5%, 1/2W	4704-108761	01121	Same as R103	REF		
R610, R611	Res, comp, 100K ±10%, 1/2W	4704-108126	01121	Same as R215	REF		
R612	Res, comp, 2.2K ±10%, 1/2W	4704-108605	01121	Same as R401	REF		
R613	Res, met flm, 10.2Ω ±1%, 1/2W	4705-182568	75042	Type CEC-TO	1		
R614	Res, comp, 7.5K ±5%, 1/2W	4704-108910	01121	EB7525	1		
R615	Res, var, WW, 50Ω ±10%, 1-1/4W	4702-144782	71450	Type 110	1		
R616	Res, met flm, 15K ±1%, 1/2W	4705-151498	75042	Type CEC-TO	1		
R617	Res, var, WW, 5K ±5%, 1-1/4W	4702-163709	71450	Type 110	1		
R618	Res, comp, 36K ±5%, 1/2W	4704-185991	01121	EB3635	1		
R619	Res, comp, 12Ω ±5%, 1/2W	4704-187831	01121	EB1205	1		
R620	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	Same as R2	REF		
R621, R622	Res, comp, 10K ±10%, 1/2W	4704-108118	01121	EB1031	2		
R623	Res, comp, 16K ±5%, 1/2W	4704-159632	01121	EB1635	1		
R624	Res, comp, 4.7K ±10%, 1/2W	4704-108381	01121	Same as R221	REF		
R625	Res, comp, 330K ±10%, 1/2W	4704-108274	01121	EB3341	1		

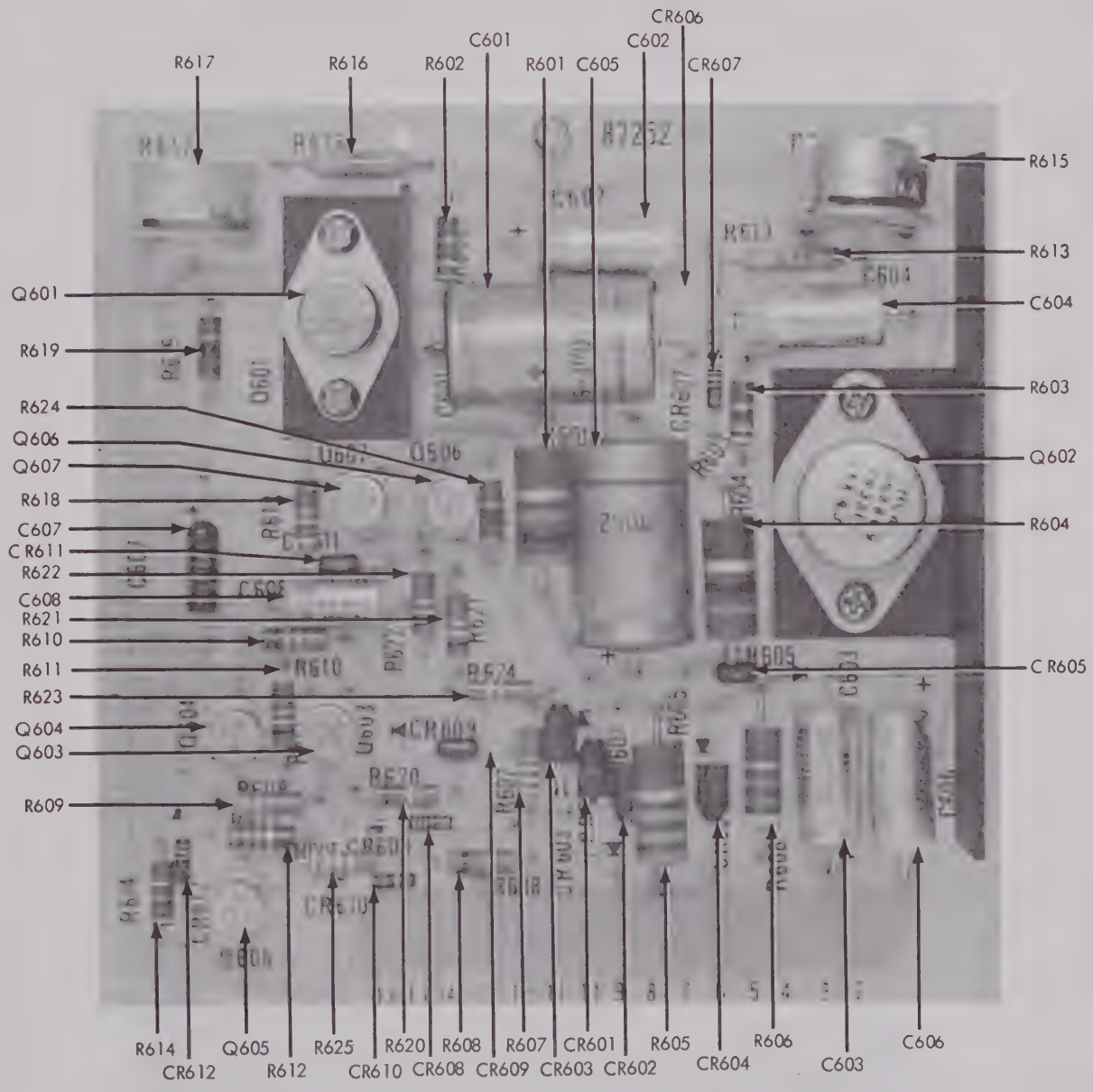


Figure 5-7. CURRENT LIMIT ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Front Mother Board Assembly	1702-187260 (332A-407)			1		
C701	Cap, plstc, 0.1 uf ±20%, 200V	1507-106435	56289	Same as C207	REF		
CR701	Diode, zener, 6.8V, 0.400W	4803-166199	07910	1N754	2		∼A
	Diode, zener, 6.8V, 0.400W	4803-187195	07910	CD36554	1		∼C
R701, R702	Res, car flm, 300K ±1%, 2W	4703-107425	00327	Type C14	2		
R703	Res, met flm, 60.4K ±1%, 1/2W	4705-161067	75042	Type CEC-TO	1		
R704	Res, met flm, 5.76K ±1%, 1/2W	4705-186080	75042	Type CEC-TO	1		
R705, R706	Res, met flm, 5M ±1%, 1W	4703-107458	00327	Type C13	2		
R707	Res, met flm, 1M ±1%, 1/2W	4705-161075	75042	Type CEC-TO	1		
R708	Res, met flm, 100K ±1%, 1/2W	4705-151316	75042	Same as R102	REF		

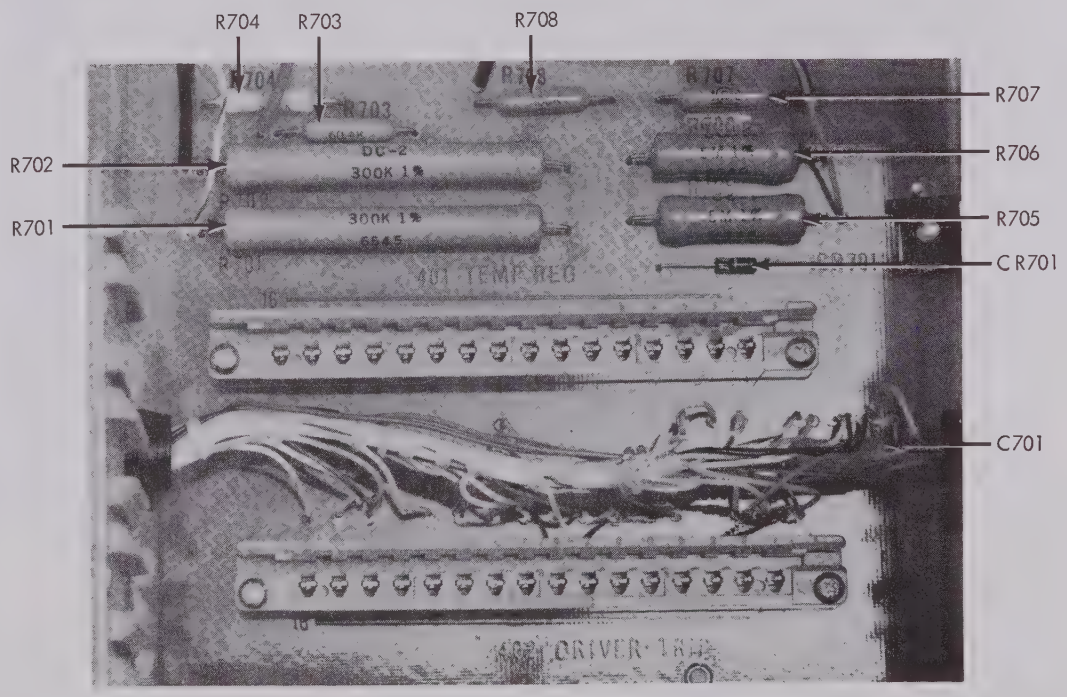


Figure 5-8. FRONT MOTHER BOARD ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	High Voltage Rectifier Assembly	1702-187294 (332A-410)	89536		1		
C1001	Cap, cer, 0.001 uf ±20%, 3 KV	1501-105635	56289	29C300	1		
C1002	Cap, Al elect, 50 uf -10/+75%, 50V	1502-105122	56289	30D506G050DH4	1	1	
CR1001 to CR1012	Diode, Si, 600 PIV, 1A	4802-112383	14099	Same as CR1	REF		
CR1013	Diode, zener, 110V, 0.005A	4803-168104	81483	1N3045A	1	1	
CR1014	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
K1001, K1002	Relay, reed, 5000 VDC, 3A	5103-184440	12617	DRVT-1	2		
	Coil, 24V, 15000 Turns, 150 AT	1802-186155	71707	SP-24-P	3		
R1001	Res, comp, 470Ω ±10%, 1W	4704-109710	01121	GB4711	1		
R1002	Res, comp, 56Ω ±10%, 2W	4704-110221	01121	HB5601	1		
R1003, R1004	Res, comp, 1K ±10%, 2W	4704-109942	01121	HB1021	3		
R1005, R1006	Res, comp, 8.2K ±10%, 2W	4704-110072	01121	HB8221	2		

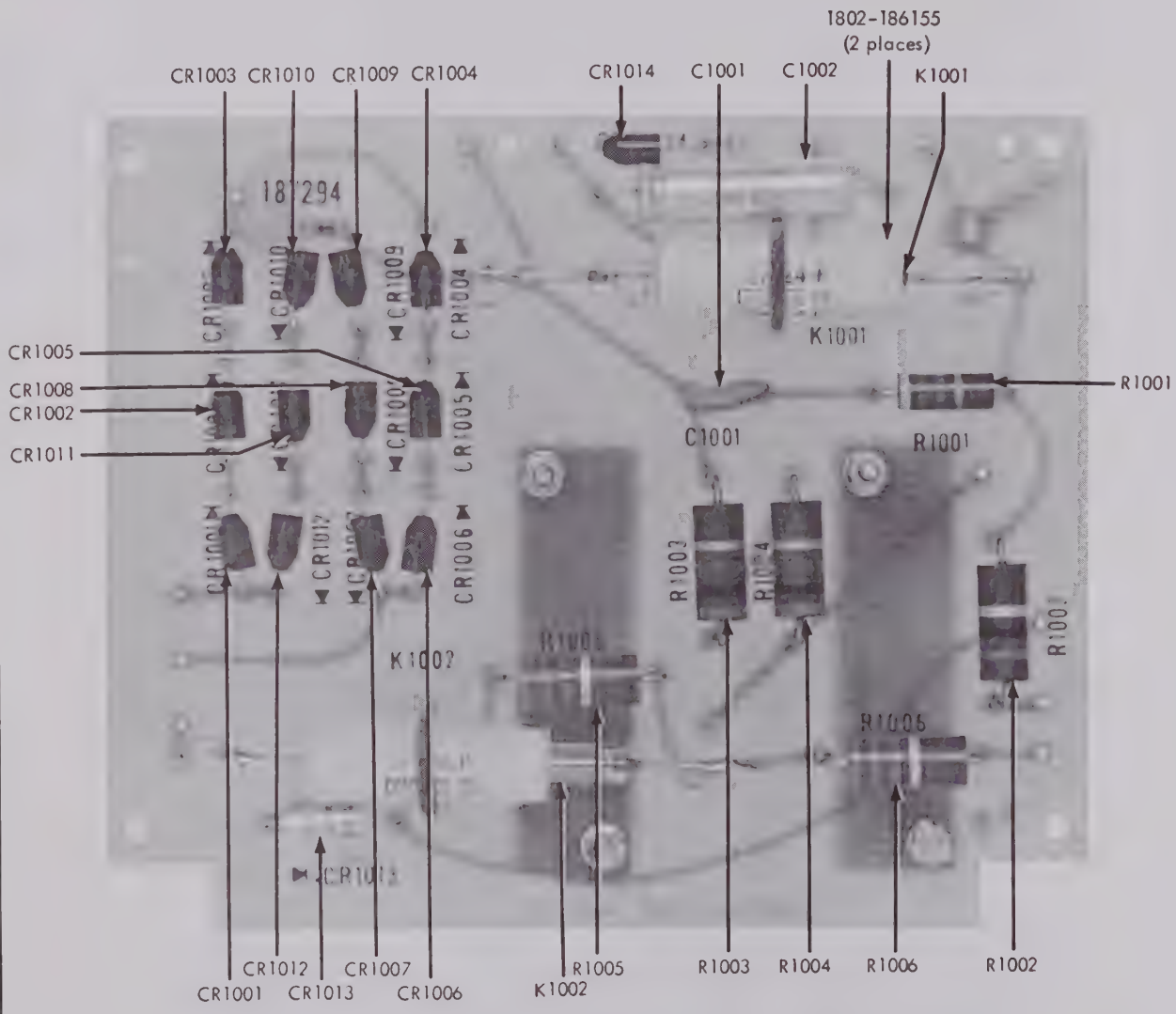


Figure 5-9. HV RECTIFIER ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Pass Element Assembly	1702-187302 (332A-411)	89536				
C1101	Cap, cer, 0.05 uf -20/+80%, 500V	1501-105676	56289	Same as C1	REF		
C1102	Cap, Al elect, 8 uf -10/+50%, 450V	1502-194068	56289	39D805F450HE4	1	1	
C1103	Cap, cer, 0.05 uf -20/+80%, 500V	1501-105676	56289	Same as C1	REF		
C1104	Cap, plstc, 0.047 uf ±10%, 200V	1507-186262	56289	192P47392	1		I
	Cap, plstc, 0.022 uf ±10%, 200V	1507-159400	56289	2239R8	1		J
C1105	Cap, cer, 0.01 uf -20/+80%, 500V	1501-105668	56289	29C9B5	1		J
CR1101 to CR1108	Diode, Si, 600 PIV, 1A	4802-112383	14099	Same as CR1	REF		
CR1109	Diode, zener, 6.8V, 0.400W	4803-166199	07910	Same as CR701	REF		M
	Diode, zener, 6.2V, 0.400W	4803-180497	07910	1N753	1	1	H
CR1110	Diode, Si, 600 PIV, 1A	4802-112383	14099	Same as CR1	REF		
CR1111	Diode, zener, 36V, 0.400W	4803-186163	07910	Same as CR606	REF		
CR1112	Diode, zener, 20V, 0.400W	4803-113340	07910	1N968A	1	1	
CR1113 to CR1115	Diode, Si, 600 PIV, 1A	4802-112383	14099	Same as CR1	REF		
CR1116	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
CR1117	Diode, Si, 600 PIV, 1A	4802-112383	14099	Same as CR1	REF		
Q1101	Transistor, unijunction, N-channel, Si	4805-117176	89730	2N1671	1	1	
Q1102, Q1103,	Transistor, NPN, Si	4805-178525	95303	40264	3	1	E
Q1104	Transistor, NPN, Si (use 4805-190710 for replacement)	4805-190710	04713	2N3739	3	1	F
Q1105	Transistor, NPN, Si	4805-190710	01121	2N3739	1	1	
R1101	Res, comp, 1K ±10%, 2W	4704-109942	01121	Same as R1003	REF		
R1102	Res, comp, 150K ±10%, 1W	4704-109801	01121	GB1541	1		
R1104 to R1106	Res, comp, 1.8K ±10%, 2W	4704-185983	01121	HB1821	3		
R1107	Res, comp, 220Ω ±10%, 1/2W	4704-108191	01121	EB2211	1		
R1108	Res, comp, 180Ω ±10%, 1/2W	4704-108571	01121	EB1811	1		
R1109	Res, comp, 20K ±5%, 1/2W	4704-109041	01121	Same as R220	REF		I
	Res, comp, 36K ±5%, 1/2W	4704-185991	01121	EB3635	1		J
R1110	Res, comp, 20K ±5%, 1/2W	4704-109041	01121	Same as R220	REF		I
	Res, comp, 220K ±10%, 1/2W	4704-108217	01121	EB2241	1		J
R1111	Res, comp, 100K ±10%, 1/2W	4704-108126	01121	Same as R215	REF		
R1112	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	Same as R2	REF		
R1113	Res, comp, 100K ±10%, 1/2W	4704-108126	01121	Same as R1111	REF		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R1114	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	Same as R2	REF		
R1115	Res, comp, 100K ±10%, 1/2W	4704-108126	01121	Same as R1111	REF		
R1116	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	Same as R3	REF		
R1117, R1118, R1119	Res, comp, 100K ±10%, 1/2W	4704-108126	01121	Same as R1111	REF		
R1120, R1121, R1122	Res, comp, 56K ±10%, 2W	4704-109991	01121	HB5631	3		
R1123	Res, comp, 1.1Ω ±5%, 1/2W	4704-163717	06751	EB11G5	1		
R1124	Res, comp, 20K ±5%, 1/2W	4704-109041	01121	Same as R1109	REF		I
	Res, comp, 220K ±10%, 1/2W	4704-108217	01121	EB2241	1		J
R1125	Res, comp, 62K ±5%, 1/2W	4704-108522	06751	EB6235	1		I
T1101	Transformer, pulse	5600-185827	89536		1		

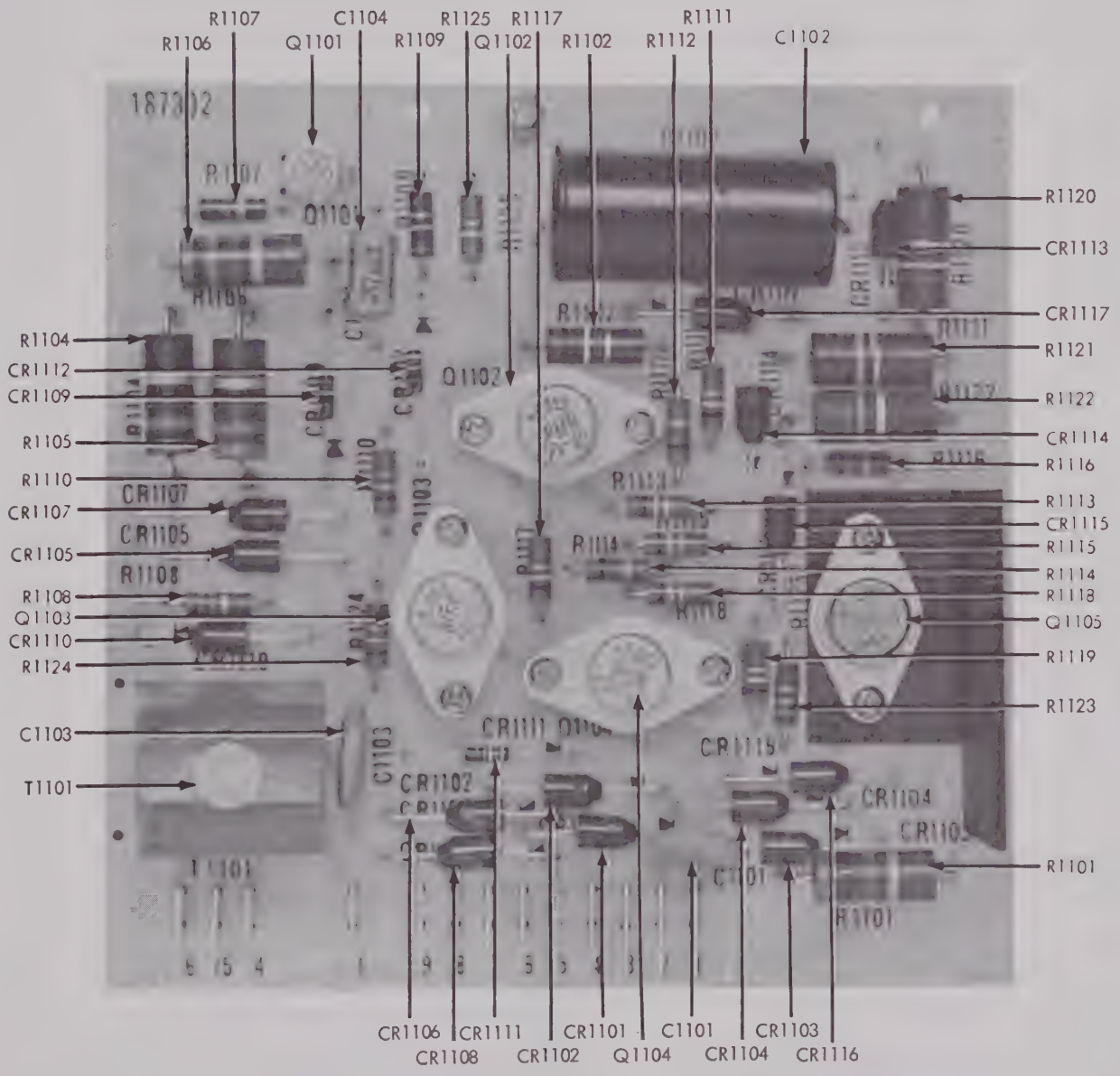


Figure 5-10. SERIES PASS ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Pre-regulator Assembly	1702-187310 (332A-412)	89536				
C1201 C1202	Cap, cer, 0.05 uf -20/+80%, 500V	1501-105676	56289	Same as C1	REF		
C1203	Cap, plstc, 1 uf ±20%, 200V	1507-106450	84411	Same as C1601	REF		
C1204	Cap, Al elect, 1000 uf -10/+50%, 16V	1502-193896	73445	C437ARE1000	1	1	
C1205 C1206	Cap, cer, 0.05 uf -20/+80%, 500V	1501-105676	56289	Same as C1	REF		
C1207	Cap, plstc, 1 uf ±20%, 200V	1507-106450	84411	Same as C1601	REF		
CR1201 to 1204	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
CR1205 to 1208	Diode, Si, 200 PIV, 3A	4802-187716	04713	MR1032B	4	1	
CR1209	Diode, zener, 200V, 0.2A	4803-187617	04713	1N3350RA	1	1	
CR1210 to 1212	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
CR1213 to 1216	Diode, Si, 600 PIV, 1A	4802-112383	14099	Same as CR1	REF		
K1201	Relay, DPDT, 115 VAC, 5A	4501-106864	16332	100DPDT	1		
K1202	Relay, reed, 500V, 1A	5103-136630	12617	Type DRG-1	1		
	Coil, 24V, 15000 Turns, 150 AT	1802-186155	71707	SP-24-P	REF		
Q1201	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		K
	Transistor, NPN, Si	4805-150359	95303	2N3053	1		L
Q1202	Transistor, PNP, Si	4805-169375	07263	2N3638	3	1	K
	Transistor, PNP, Si	4805-190389	04713	SM4144	1		L
Q1203	Transistor, PNP, Si	4805-196375	07263	Same as Q1202	REF		
Q1204	Transistor, NPN, Si	4805-193870	04713	Same as Q101	REF		
Q1205	Transistor, PNP, Si	4805-169375	07263	Same as Q1202	REF		
Q1206	Transistor, NPN, Si	4805-170779	95303	2N1479	1		A
	Transistor, NPN, Si	4805-183004	95303	Same as Q104	REF		C
Q1207	Transistor, NPN, Si	4805-193953	64834	320C034H31	1		
R1201	Res, comp, 68Ω ±10%, 2W	4704-110205	01121	HB6801	1		
R1202	Res, comp, 4.7K ±5%, 1/2W	4704-108886	01121	EB4725	1		
R1203	Res, comp, 3.3K ±5%, 1/2W	4704-165761	01121	EB3325	1		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R1204	Res, comp, 120Ω ±10%, 1/2W	4704-108696	01121	EB1211	2		
R1205	Res, comp, 180Ω ±5%, 1/2W	4704-108944	01121	EB1815	1		
R1206	Res, comp, 270Ω ±5%, 1/2W	4704-159616	01121	EB2715	2		
R1207	Res, comp, 22K ±5%, 1/2W	4704-186064	01121	EB2235	1		
R1208	Res, comp, 360Ω ±5%, 1/2W	4704-192559	01121	EB3615	1		
R1209	Res, comp, 150Ω ±5%, 1/2W	4704-186056	01121	EB1515	1		A
	Res, comp, 430Ω ±5%, 1/2W	4704-109058	01121	EB4315	1		C
R1210	Res, WW, 0.2Ω ±1%, 1/4W	4707-131896	89536	Same as R2702	REF		A
	Res, WW, 0.1Ω ±1%, 1/4W	4707-131904	89536	Same as R2701	REF		C
R1211	Res, WW, 2.5K ±5%, 5W	4706-187591	06136	5F2500	1		
R1212	Res, comp, 270Ω ±5%, 1/2W	4704-159616	01121	Same as R1206	REF		
R1213	Res, comp, 1K ±5%, 1/2W	4704-108597	01121	Same as R304	REF		
R1214	Res, comp, 120Ω ±10%, 1/2W	4704-108696	01121	Same as R1204	REF		
R1215	Res, comp, 51Ω ±5%, 1W	4704-157586	01121	GB5105	1		
R1216, R1217	Res, comp, 12Ω ±10%, 2W	4704-193888	01121	HB1201	2		A
	Res, WW, 10Ω ±10%, 5W	4706-112300	06136	5F10	2		C
R1218	Res, WW, 0.1Ω ±1%, 1/4W (not illustrated)	4707-131904	89536	Same as R2701	REF		C

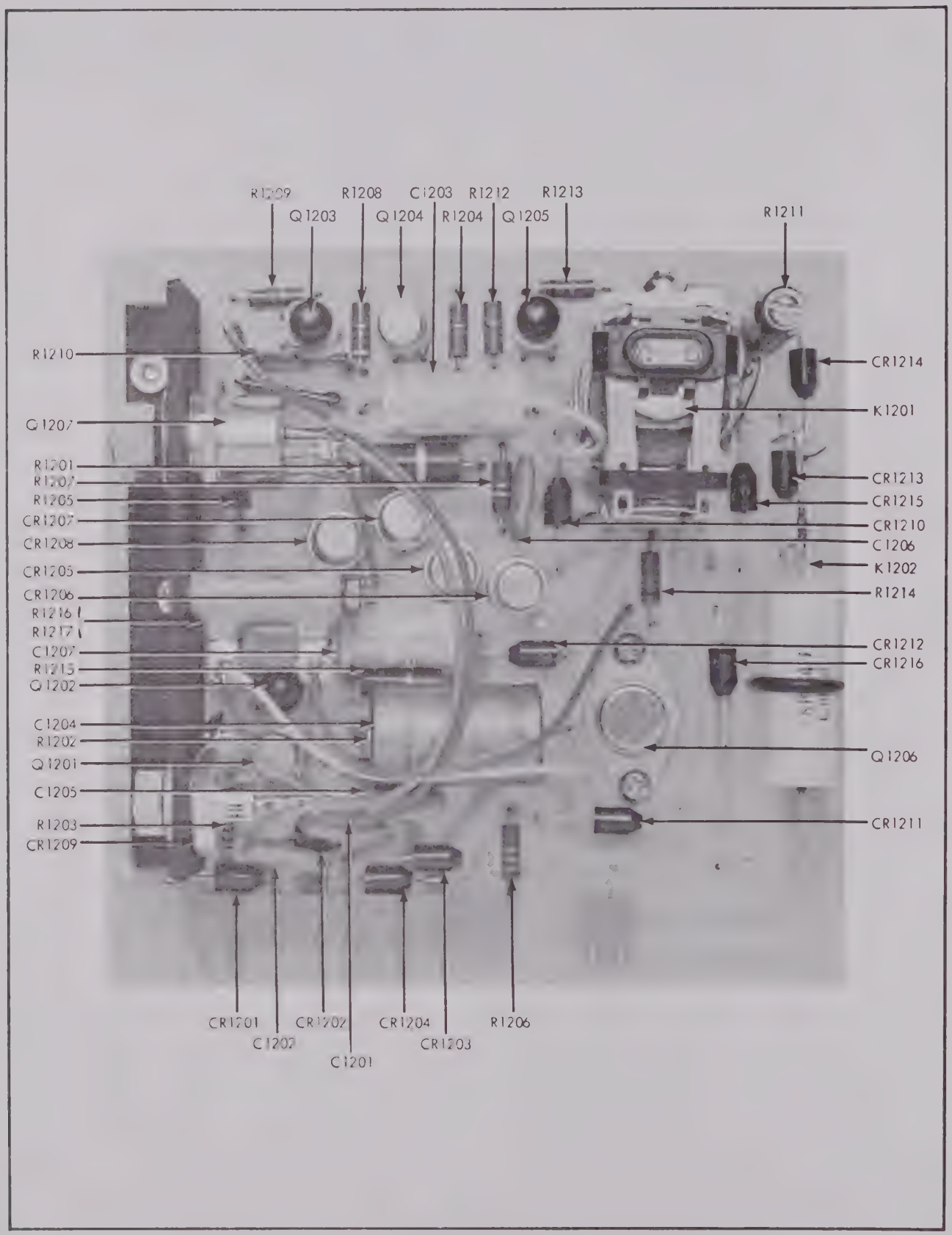


Figure 5-11. PREREGULATOR ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Rear Mother Board Assembly	1702-187328 (332A-413)					
C1301, C1302, C1303	Cap, Al elect, 125 uf -10/+50%, 450V	1502-106336	56289	Type 66D	3	1	
	NOTE: Use Sprague capacitors only.						
C1304	Cap, plstc, 1 uf ±20%, 200V	1507-106450	84411	Same as C1601	REF		
C1305	Cap, oil, 3 uf ±2.0%, 236 VAC	1505-185926	56289	200P1640	1		
R1301 to R1306	Res, comp, 220K ±10%, 2W	4704-110197	01121	HB2241	6		
R1307	Res, comp, 270Ω ±10%, 2W	4704-110189	01121	HB2711	1		
R1308, R1309	Res, comp, 10Ω ±10%, 2W	4704-110163	01121	HB1001	2		

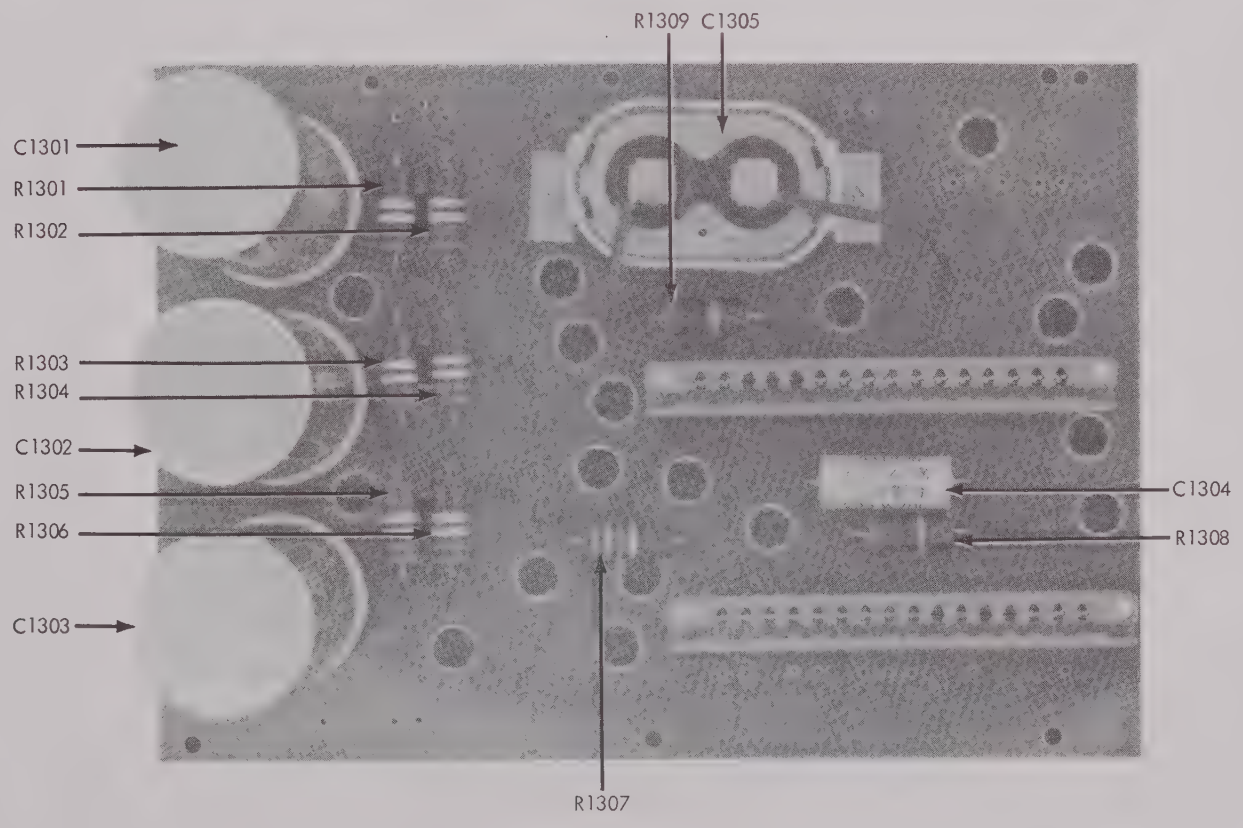


Figure 5-12. REAR MOTHER BOARD ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Time Delay Assembly	1702-192260 (332A-420)	89536				
C2001	Cap, Al elect, 400 uf -10/+50%, 40V	1502-185868	73445	C437ARG400	1	1	
CR2001, CR2002, CR2003	Diode, Si, 100 PIV, 1A	4802-116111	14099	Same as CR3	REF		
K2001	Relay, DPDT, 115 VAC, 2A	4504-176347	88690	62-760	1		
Q2001	SCR, 50V breakover, 1 ma trigger current	4805-192567	89473	CF6	1		
R2001	Res, comp, 2.2K ±10%, 2W	4704-109967	01121	HB2221	1		
R2002	Res, comp, 5.6K ±10%, 1/2W	4704-108324	01121	EB5621	1		
R2003	Res, comp, 390Ω ±10%, 1/2W	4704-108365	01121	EB3911	1		
R2004	Res, comp, 10K ±10%, 1/2W	4704-108118	01121	Same as R204	REF		

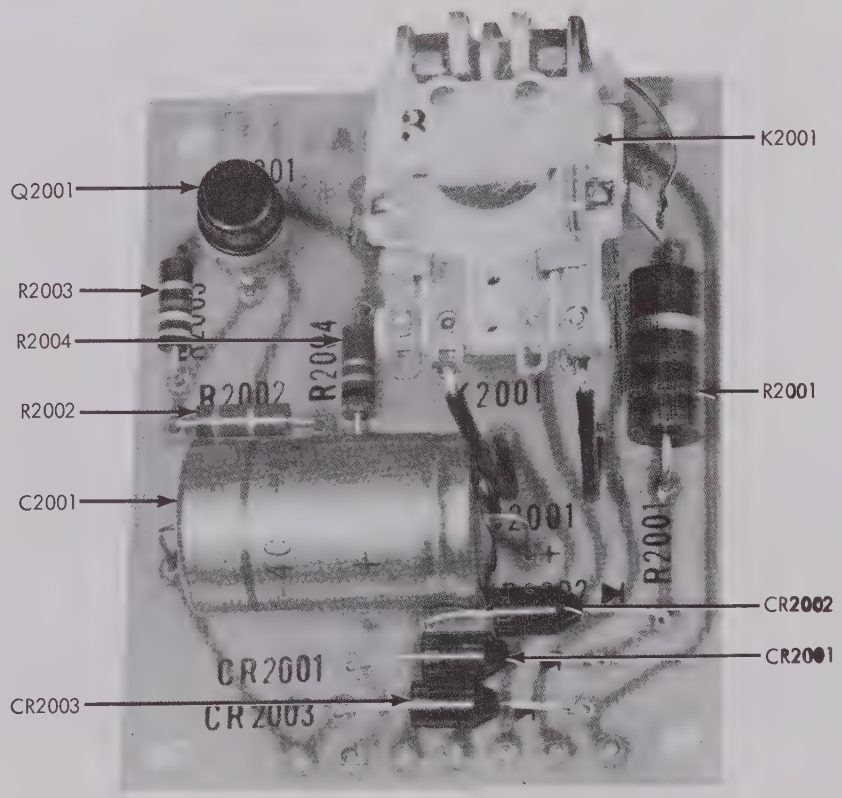


Figure 5-13. TIME DELAY ASSEMBLY

5-8. USE CODE EFFECTIVITY

5-9. The following list of use codes is intended to allow the customer to determine the effectivity of all replaceable parts. All parts with no code are used on all instruments having serial numbers 123 and on. New codes will be added as required by instrument changes.

USE CODE	EFFECTIVITY
No Code	Model 332A serial number 123 and on.
A	Model 332A serial number 123 thru 282.
B	Model 332A serial number 233 and on.
C	Model 332A serial number 283 and on.
D	Model 332A serial number 175, 197, 221, 225, 242, 248, 249, 250, 263, 268, and on.
E	Model 332A serial number 123 thru 332.
F	Model 332A serial number 333 and on.
G	Model 332A serial number 123 thru 294.
H	Model 332A serial number 298 and on.
I	Model 332A serial number 123 thru 130, 133 thru 152, 154 thru 157, 159 thru 311, 313 thru 327, 329 thru 333, and 336 thru 357.
J	Model 332A serial number 131, 132, 153, 158, 312, 328, 334, 335, 358 and on.
K	Model 332A serial number 123 thru 342.
L	Model 332A serial number 343 and on.
M	Model 332A serial number 123 thru 297.
N	Model 332A serial number 291 and on.
O	Model 332A serial number 513 and on.

APPENDIX A

FEDERAL SUPPLY CODE FOR MANUFACTURERS

A-1. CODE TO NAME

A-2. The following five-digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name. Suppliers not listed in the Federal Supply Code for Manufacturers have been assigned an alphabetical code by FLUKE.

00213	Sage Electronics Corp. Rochester, New York
00327	Welwyn International, Inc. Cleveland, Ohio
00656	Aerovox Corp. New Bedford, Massachusetts
01121	Allen-Bradley Company Milwaukee, Wisconsin
01281	Pacific Semiconductors Inc. Lawndale, California
01295	Texas Instruments, Inc. Semiconductor Components Div. Houston, Texas
01730	Circle Mfg. Co. Inc. Little Falls, New Jersey
01884	Dearborn Electronic Labs Inc. Orlando, Florida
01963	Cherry Electrical Products Corp. Highland Park, Illinois
02660	Amphenol-Borg Elect. Corp. Chicago, Illinois
02606	Fenwal Laboratories Inc. Framington, Massachusetts
02799	Arco Capacitors, Inc. Los Angeles, California
03614	Bussmann Mfg. Div. of McGraw-Edison Co. Los Angeles, California
03615	Ohmite Mfg. Co. Los Angeles, California
03877	Transitron Electronic Corp. Wakefield, Massachusetts
03911	Clairex Corp. New York, New York
03980	Muirhead Instruments, Inc. Mountainside, New Jersey
04009	Arrow Hart and Hegemen Electronic Company Hartford, Connecticut
04062	Elmenco Products Company New York, New York
04202	Winchester Electronics Co. New Milford, Connecticut
04221	Telex-Aemco Division of Telex Corp. Mankato, Minnesota
04645	Kurz-Kasch, Inc. Chicago, Illinois
04713	Motorola Inc. Semiconductor Products Division Phoenix, Arizona
05082	Tung-Sol Electric Inc. Melrose Park, Illinois
05278	Penn-East Engrg. Corp. Kutztown, Pennsylvania
05397	Union Carbide Corp. Linde Division Kemet Dept. Cleveland, Ohio
05571	Sprague Electric Company Culver City, California
05704	Alac, Inc. Glendale, California
06001	General Electric Company Capacitor Department Irmo, South Carolina
06136	Ward Leonard Electric Co. Los Angeles, California
06473	Amphenol Space and Missile Sys Chatsworth, California
06555	Beede Electrical Inst. Co. Penacook, New Hampshire
06751	Nuclear Corporation of America, Inc. U. S. Semcor Div. Phoenix, Arizona
06860	Gould National Batteries Inc. La Puente, California
07115	Corning Glass Works Electronic Components Dept. Bradford, Pennsylvania
07263	Fairchild Semiconductor Div. of Fairchild Camera and Instrument Corp. Mountain View, California
07344	Bircher Co., Inc. Rochester, New York
07792	Lerma Engineering Corp. Northampton, Massachusetts
07910	Continental Device Corp. Hawthorne, California
08530	Reliance Mica Corp. Brooklyn, New York
08863	Nylomatic Corp. Morrisville, Pennsylvania
08988	Skottie Electronics Inc. Peckville, Pennsylvania
11237	Chicago Telephone of Calif Inc. South Pasadena, California
11503	Keystone Mfg. Co. Warren, Michigan
12060	Diodes, Inc. Chatsworth, California
12136	Philadelphia Handle Co. Camden, New Jersey
12400	International Resistance Co. Control Components Division Philadelphia, Pennsylvania
12617	Hamlin Inc. Lake Mills, Wisconsin
12697	Clarostat Mfg. Co. Dover, New Hampshire
14099	Semtech Corp. Newbury Park, California
14193	California Resistor Corp. Santa Monica, California
14298	American Components Inc. Conshohocken, Pennsylvania
14752	Electro Cude Inc. South Pasadena, California
15818	Amelco Inc. Mountain View, California
15909	Daven Division Thomas A. Edison Ind. McGraw Edison Co. Livingston, New Jersey
16332	Milwaukee Relays Inc. Cedarburg, Wisconsin
16473	Cambridge Scientific Industries Inc. Cambridge, Maryland
17069	Circuit Structures Lab Santa Ana, California
17856	Siliconix Inc. Sunnyvale, California
17910	Continental Device Corp. Hawthorne, California
18083	Clevite Corp. Transistor Division Palo Alto, California
19429	Montronics, Inc. Seattle, Washington
19701	Electra Mfg. Co. Independence, Kansas
24655	General Radio Co. West Concord, Mass.
28520	Heyman Mfg. Co. Kenilworth, New Jersey
33173	General Electric Co. Tube Dept. Owensboro, Kentucky
37942	P. R. Mallory and Co., Inc. Indianapolis, Indiana
38315	Honeywell Inc. Precision Meter Division Manchester, New Hampshire
42498	National Company, Inc. Malden, Massachusetts
44655	Ohmite Mfg. Co. Skokie, Illinois
49671	Radio Corp. of America New York, New York
53021	Sangamo Electric Co. Springfield, Illinois
55026	Simpson Electric Company Chicago, Illinois
56289	Sprague Electric Co. North Adams, Mass.
58474	Superior Electric Co. Bristol, Connecticut
60399	Torrington Mfg. Co. Torrington, Connecticut
62460	USHCO Mfg. Co., Inc. Buffalo, New York
64834	West Mfg. Co. San Francisco, California
65092	Weston Instruments Div. of Daystrom, Inc. Newark, New Jersey
66150	Winslow Tele-Tronics Inc. Asbury Park, New Jersey
70563	Amperite Co. Union City, New Jersey
70903	Belden Mfg. Co. Chicago, Illinois

71400 Bussman Manufacturing Division of McGraw Edison Co. St. Louis, Missouri

71450 CTS Corp. Elkhart, Indiana

71468 Cannon Electric Company Los Angeles, California

71482 Clare, C. P. and Company Chicago, Illinois

71590 Centralab Div. of Globe Union, Inc. Milwaukee, Wisconsin

71707 Coto Coil Co., Inc. Providence, Rhode Island

71744 Chicago Miniature Lamp Works Chicago, Illinois

71785 Cinch Mfg. Co. and Howard B. Jones Div. Chicago, Illinois

72005 Driver, Wilber B., Co. Newark, New Jersey

72092 Eitel-McCullough, Inc. San Bruno, California

72136 Electro Motive Mfg. Co. Willimantic, Connecticut

72354 Fast, John E. Co. Div. of Victoreen Instr. Co. Chicago, Illinois

72559 Essex Electronics Inc. Berkeley Heights, New Jersey

72619 Dialight Corp. Brooklyn, New York

72665 Mallory Battery Company Cleveland, Ohio

72982 Erie Tech. Products Inc. Erie, Pennsylvania

73138 Helipot Division of Beckman Instruments Inc. Fullerton, California

73293 Hughes Products Div. of Hughes Aircraft Co. Newport Beach, California

73445 Amperex Electronic Co. Div. of North American Philips Co., Inc. Hicksville, New York

73559 Carling Electric Inc. Hartford, Connecticut

73586 Circle F Mfg. Co. Trenton, New Jersey

73899 JFD Electronics Corp. Brooklyn, New York

73949 Guardian Electric Mfg. Co. Chicago, Illinois

74217 Radio Switch Corp. Marlboro, New Jersey

74306 Piezo Crystal Company Carlisle, Pennsylvania

74542 Hoyt Elect. Instr. Works Penacook, New Hampshire

74970 Johnson, E. F., Co. Waseca, Minnesota

75042 International Resistance Co. Philadelphia, Pennsylvania

75915 Littelfuse Inc. Des Plaines, Illinois

76854 Oak Mfg. Co. Crystal Lake, Illinois

77342 American Machine and Foundry Company Potter & Brumfield Div. Princeton, Indiana

77969 Rubbercraft Corp. of California Ltd. Torrance, California

78277 Sigma Instruments, Inc. South Braintree, Mass.

79136 Waldes Kohinoor Inc. Long Island City, New York

79497 Western Rubber Company Goshen, Indiana

80031 Mepco Division of Sessions Clock Co. Morristown, New Jersey

80294 Bourns Laboratories, Inc. Riverside, California

80583 Hammarlund Company, Inc. New York, New York

80640 Stevens, Arnold Co., Inc. Boston, Massachusetts

81073 Grayhill Company La Grange, Illinois

81439 Therm-O-Disc Inc. Mansfield, Ohio

81483 International Rectifier Corp El Segundo, California

81590 Korry Mfg. Co. Seattle, Washington

82376 Astron Division Renwell Industries Inc. East Newark, New Jersey

82389 Switchcraft Inc. Chicago, Illinois

82872 Roanwell Corp. Brooklyn, New York

82877 Rotron Mfg. Co., Inc. Woodstock, New York

82879 Royal Electric Corp. Pawtucket, Rhode Island

83003 Varo Mfg. Co., Inc. Garland, Texas

83298 Bendix Corp. Red Bank Division Red Bank, Eatontown, New Jersey

83330 Smith, Herman H., Inc. Brooklyn, New York

83478 Rubbercraft Corp. of Am. New Haven, Connecticut

84411 Good All Electric Mfg. Co. Ogallala, Nebraska

86689 R. M. B. Corp. Los Angeles, California

88419 Cornell-Dubilier Elec. Corp. Electro-Mechanical Div. Fuquay Springs, North Carolina

88690 Essex Wire Corp. R. B. M. Division Detroit, Michigan

89536 Fluke, John, Mfg. Co., Inc. Seattle, Washington

89730 General Electric Company Newark Lamp Works of Lamp Division of Consumer Products Group GECO Newark, New Jersey

90205 Best Stamp and Mfg. Co. Kansas City, Missouri

90211 Square D Company Chicago, Illinois

90303 Mallory Battery Company North Tarrytown, New York

91293 Johanson Mfg. Co. Boonton, New Jersey

91407 Superior Electric Company Oak Park, Illinois

91662 Elco Corp. Willow Grove, Penn.

91737 Gremar Mfg. Co., Inc. Wakefield, Massachusetts

91802 Industrial Devices, Inc. Edgewater, New Jersey

91929 Minneapolis Honeywell Regulator Company Micro Switch Division Freeport, Illinois

91934 Miller Electric Co., Inc. Pawtucket, Rhode Island

93332 Sylvania Electric Products Inc. Semiconductor Products Division Woburn, Massachusetts

94145 Raytheon Company Semiconductor Division California Street Plant Newton, Massachusetts

95146 Alco Electronics Mfg. Co. Lawrence, Massachusetts

95264 Lerco Electronics Inc. Burbank, California

95303 Radio Corp. of America Comm. Receiving Tube & Semiconductor Division Cincinnati, Ohio

95354 Methode Mfg. Co. Chicago, Illinois

95712 Dage Electric Co., Inc. Franklin, Indiana

96733 San Fernando Electric Mfg. Co. San Fernando, California

96881 Thomson Industries, Inc. New Hyde Park Long Island, New York

97945 S. S. White Dental Mfg. Co. Plastics Division New York, New York

97966 CBS Electronics Div. of Columbia Broadcasting System, Inc. Danvers, Massachusetts

98094 Penta Laboratories, Inc. Santa Barbara, California

98388 Accurate Sales Company Culver City, California

98743 James Vibrapower Corp. Chicago, Illinois

98925 Semiconductor Division of Clevite Corp. Waltham, Massachusetts

99120 Plastic Capacitors, Inc. Chicago, Illinois

99217 Southern Electronics Corp. Burbank, California

99515 Marshall Industries Electron Prod. Div. Pasadena, California

Revised May 15, 1966
Using H4-2 Dated March 1963

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

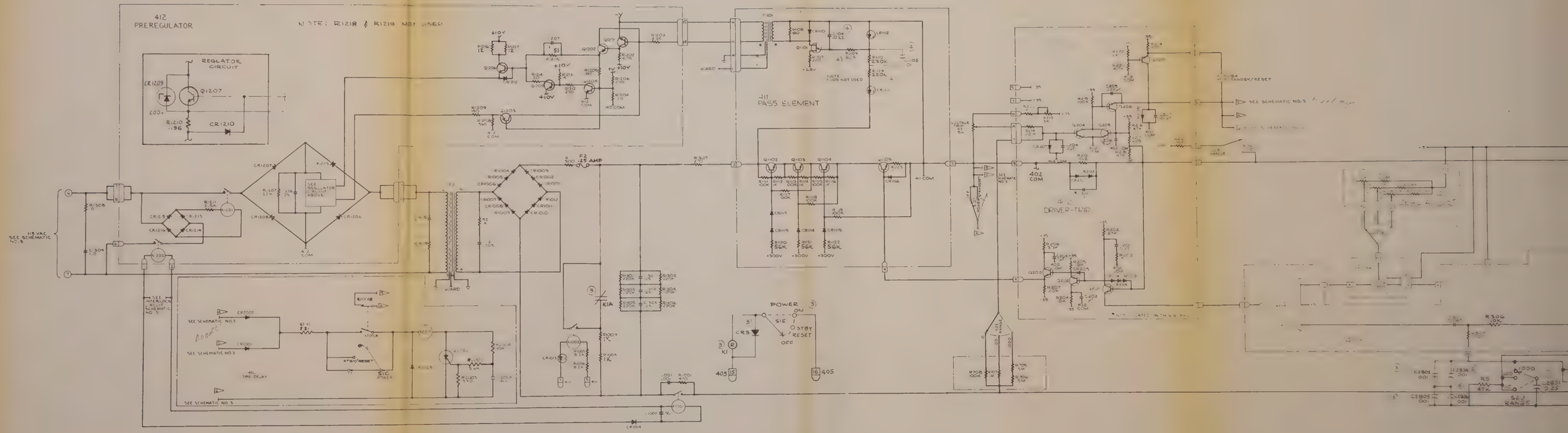
All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON


412
PREREGULATOR
NOTE: R1218 & R1219 NOT USED
REGULATOR CIRCUIT
CR1209
Q1207
200V
R1210
.196
CR1210
+10V
-V
+V
Q1201
Q1202
Q1203
Q1204
Q1205
Q1206
T1101
411 PASS ELEMENT
Q1101
Q1102
Q1103
Q1104
CR1110
CR1112
CR1111
CR1113
CR1114
CR1115
+300V
F2 .25 AMP
T2
115 VAC SEE SCHEMATIC NO. 3
CR1207
CR1208
CR1205
CR1206
CR1201
CR1202
CR1203
CR1204
SEE REGULATOR CIRCUIT ABOVE
411 COM
HARD
SEE INTERLOCK & RELAY SCHEMATIC NO. 3
SEE SCHEMATIC NO. 3
CR2007
CR2001
TIME DELAY
STBY/RESET
SIC
K1A
K1B
K2A
K2B
K2C
K2D
K2E
K2F
K2G
K2H
K2J
K2K
K2L
K2M
K2N
K2P
K2Q
K2R
K2S
K2T
K2U
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K3K
K3L
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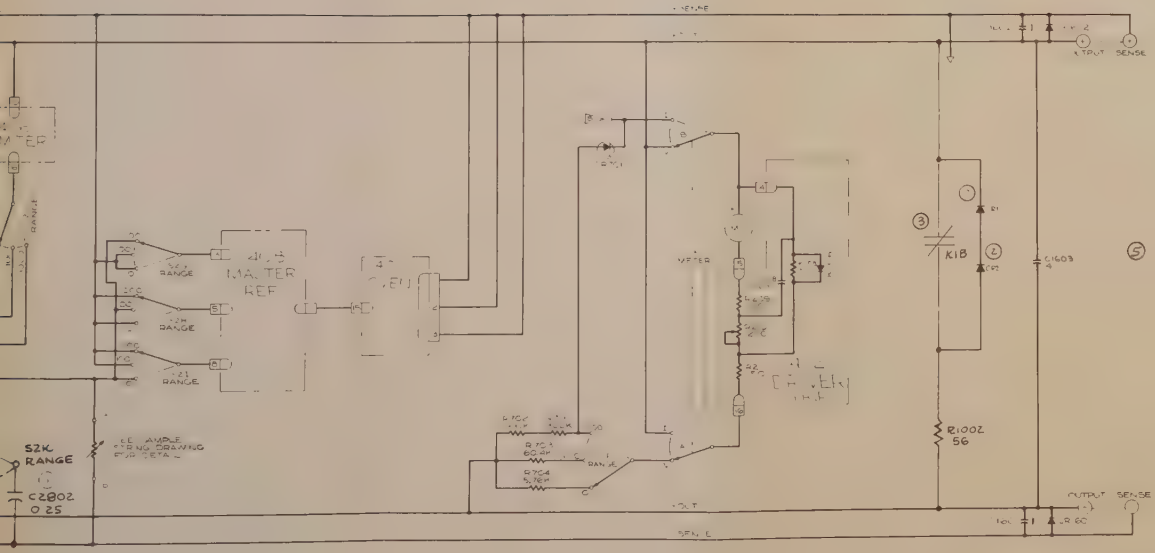
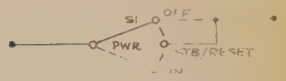
K3N
K3P
K3Q
K3R
K3S
K3T
K3U
K3V
K3W
K3X
K3Y
K3Z
K4A
K4B
K4C
K4D
K4E
K4F
K4G
K4H
K4J
K4K
K4L
K4M
K4N
K4P
K4Q
K4R
K4S
K4T
K4U
K4V
K4W
K4X
K4Y
K4Z
POWER
ON
STBY / RESET
OFF
CR3
K1
405
DRIVER-TRIP
402 COM
STANDBY/RESET
SEE SCHEMATIC NO. 3
52J RANGE
R306



(1) FOR SER. NO. 123 THRU 132
S2J & S2K NOT USED.
C2801 & C2802 CONNECTED DIRECTLY TO PIN 8 OF 403 BOARD

(2) FOR SER. NO. 123, 124, 126, 127 & 129
CR1 & CR2 NOT USED

(3) FOR SERIAL NO'S 123 THRU 312
K1 & CR3 NOT USED
K1A & K1E REPLACED BY S1C & S1E, RESPECTIVELY AS FOLLOWS:



(4) FOR SER. NO. 123 THRU 130, 133 THRU 152, 154 THRU 157, 159 THRU 311, 313 THRU 327, 329 THRU 334, 336 THRU 357
C1104 WAS 0.047 uf
C1105 NOT USED
R1109, R1110, R1124 WERE 20K
R1125 (62K) WAS CONNECTED IN PARALLED WITH C1104

NOTES:

INDICATES INNER CHASSIS GROUND

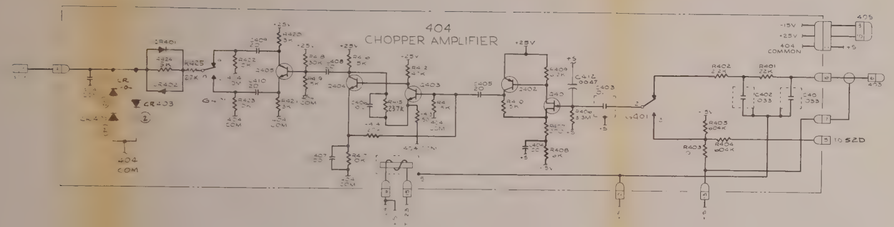
INDICATES EARTH GROUND

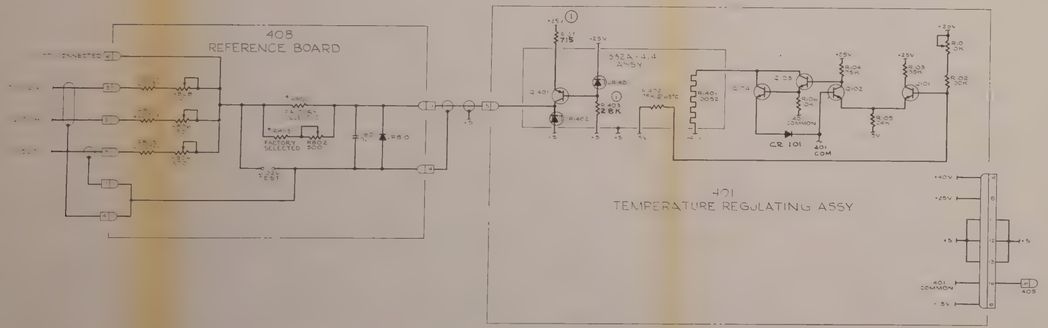
ALL CAPACITORS ARE IN MICROFARADS AND ALL RESISTORS ARE IN OHMS UNLESS OTHERWISE NOTED. K = 10^3, M = 10^6

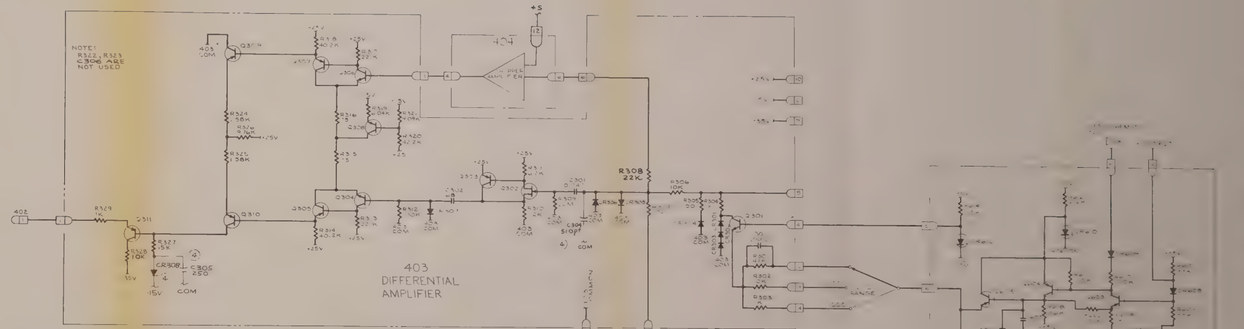
(5) FOR SER. NO. 123 THRU 290
C2803 THRU C2806
NOT USED

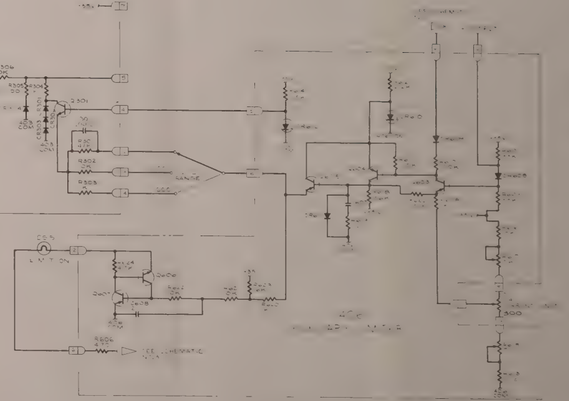
FUNCTIONAL SCHEMATIC
SCHEMATIC NO 1 — INTERCONNECTING BLOCK DIAGRAM 2
VOLTAGE STANDARD
MODEL 332A
SER. NO. 123 & UP

FLUKE JOHN FLUKE MFG CO., INC
P O Box 7428 Seattle Washington 98133



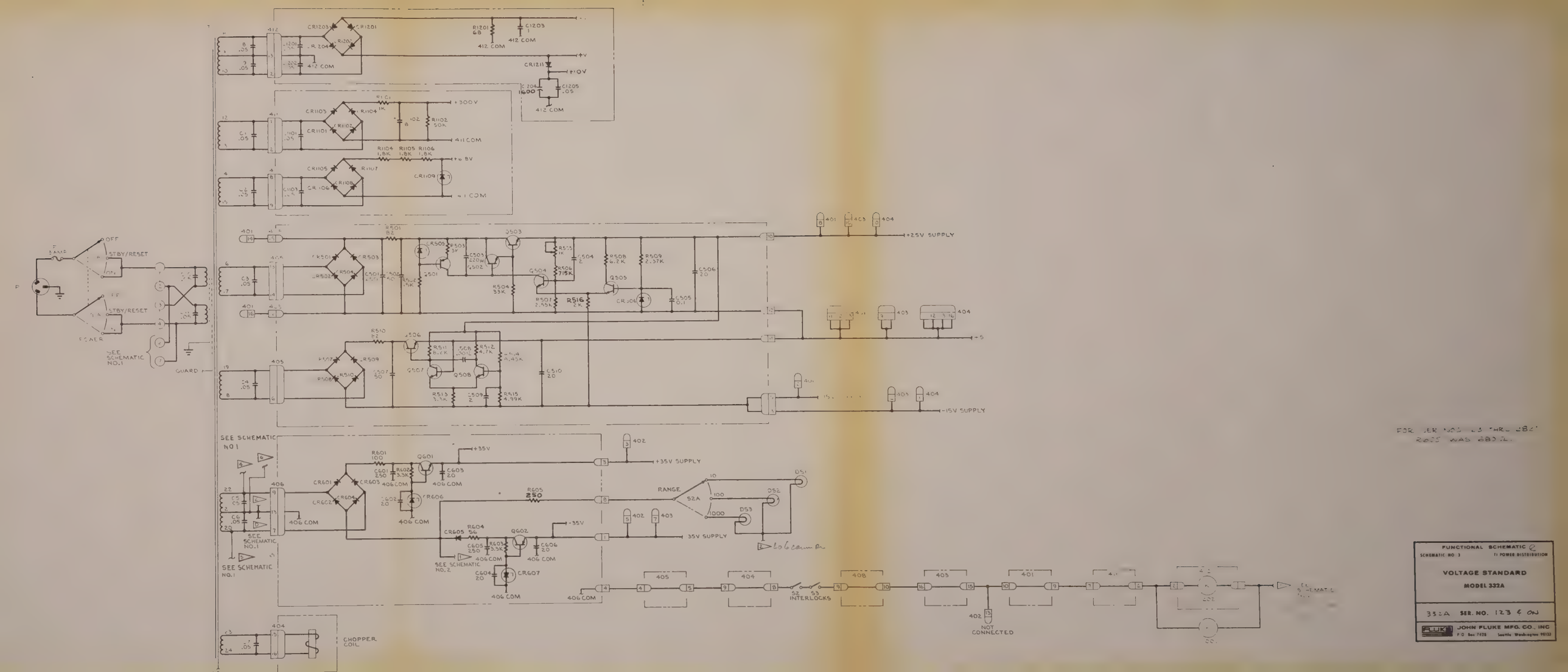


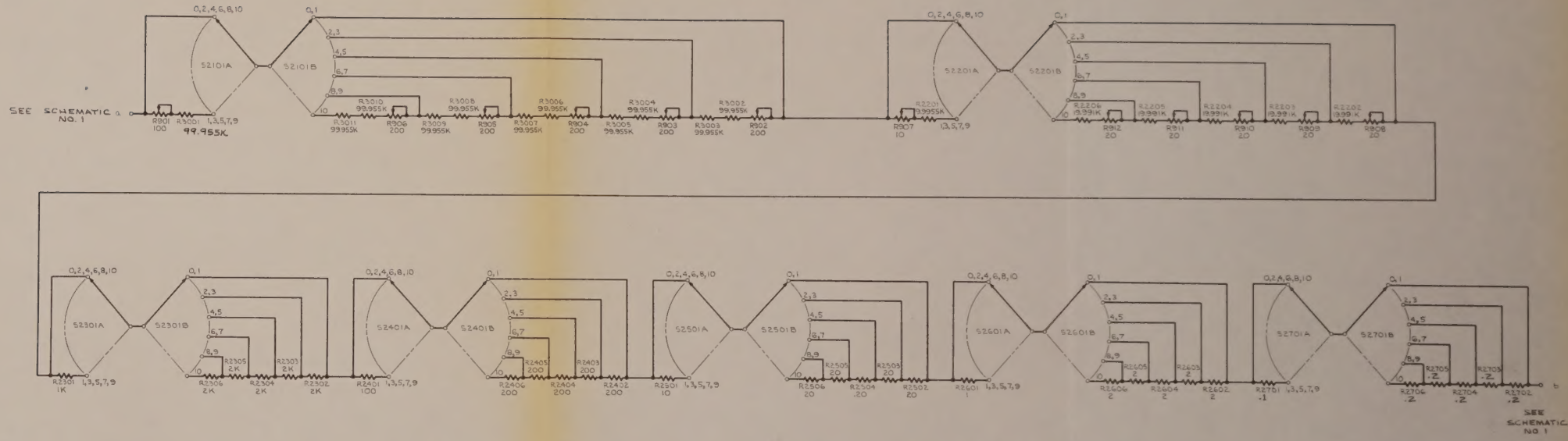




1. FOR SER NO 123 THRU 142
R107 WAS 6812.4
R1405 WAS 287 R
2. FOR SER NO 123 THRU 174,
176 THRU 196, 198 THRU 220,
222 THRU 224, 226 THRU 241,
243 THRU 247, 251 THRU 262
264 THRU 269
CR1405, CR1406, CR1407
NOT USED
3. FOR SER NO 123 THRU 294
R37 OHMS WAS CONNECTED
IN PARALLEL WITH R328
4. FOR SER NO 25 THRU 32
C306 C305 & CR308
NOT USED

FUNCTIONAL SCHEMATIC
SCHEMATIC 80.3
SUPPORT MODULES
f
VOLTAGE STANDARD
MODEL 332A
332A SER. NO. 123 & UP
FLUKE JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133


FUNCTIONAL SCHEMATIC
SCHEMATIC NO. 3
VOLTAGE STANDARD
MODEL 332A
332A SER. NO. 123 & ON
JOHN FLUKE MFG. CO., INC
P.O. Box 7428 Seattle Washington 98133
FOR SER NOS 123 THRU 282 R605 WAS 280 Ω.
+25V SUPPLY
+5
-15V SUPPLY
+35V SUPPLY
35V SUPPLY
CHOPPER COIL
RANGE
INTERLOCKS
NOT CONNECTED
SEE SCHEMATIC NO.1
SEE SCHEMATIC NO.2
406 COM
412 COM
411 COM
+1 COM
GUARD
POWER
STBY/RESET



FUNCTIONAL SCHEMATIC C

SCHEMATIC NO. 4 SAMPLE STRING

VOLTAGE STANDARD

MODEL 332A

332A SER. NO. 123 & ON

FLUKE JOHN FLUKE MFG. CO., INC.

P.O. Box 7428 Seattle, Washington 98133